SCIENCE AND CULTURE

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SCIENCE AND CULTURE

A MONTHLY JOURNAL CONDUCTED UNDER THE GUIDANCE OF THE

INDIAN SCIENCE NEWS ASSOCIATION

TO DISSEMINATE THE KNOWLEDGE OF SCIENCES AND ADVOCATE THE APPLICATION OF THIS KNOWLEDGE TO A PROGRAMME OF NATIONAL WELFARE.

Vol. 13, No. 1] [JULY, 1947

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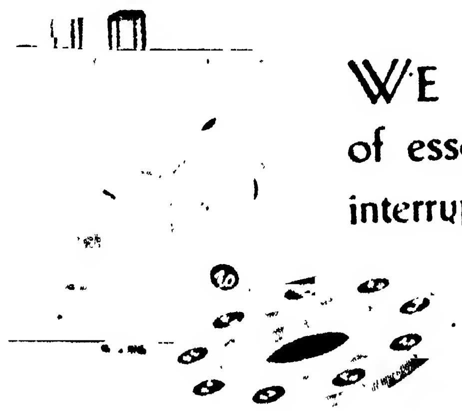

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. 13. JULY, 1947 No. 1

TWELVE YEARS OF "*SCIENCE AND CULTURE*"

TWELVE long years have passed since SCIENCE AND CULTURE started on its career. Each of these years has been charged with struggles and turmoils for freedom—freedom from want and fear, freedom for complete living. SCIENCE AND CULTURE has not remained a silent witness aloof from the awakening. On the contrary, it may rightfully claim to have rendered pioneering service in trying to discover a common purpose in life for the whole of the Indian people, discussing ways and means to achieve that purpose, and suggesting measures. May we present our readers with a snapshot of our past activities?

It was in the pages of SCIENCE AND CULTURE that the views of responsible thinkers in the country were broadcast for the first time for Planning on a National Scale. For people long accustomed to living under colonial conditions, freedom from foreign yoke is the immediate objective, which we have persistently advocated. But this is the first step to the goal and not an end in itself. Thus one of the achievements of SCIENCE AND CULTURE has been to clarify the future objectives of the country—planned development of the resources in men and material so that our people may live at par with the civilized people in other progressive countries.

To gain freedom and retain it are two vital but distinct phases of collective efforts. SCIENCE AND CULTURE has spared no pains to preach that the only way to achieve the full objective is to achieve a Technological Revolution in our methods of living and work. This alone can render the Political Revolution which has culminated in Independence worth anything. We have again and again called attention to the example of some South American Republics where political freedom, won nearly at the same time as in the U.S.A. has not been able to pull the people out of the dreadful conditions of medieval times, because they did not make use of Science and Technology in developing their national resources and utilizing the results for the uplift of the common man.

SCIENCE AND CULTURE has told the full story of experiments by Soviet Russia in this line, who, starting 30 years ago under worse conditions than in the present day India,

have not only won political and economic freedom from West European capitalism, but by means of well planned Technological Revolution has converted a nation of farmers and serfs leading miserable lives under the knout of Czars, and their Janissary guards, the nobles, militarists and chinovniks (civil servants), to one of scientists, technologists, industrial workers, and collective farmers living under their own elected representatives, and achieving a standard of life almost equal to that of pre-war Western Europe.

The key to the success of the great Technological Revolution in Russia has been scientific National Planning, by their own nationals, and with the aid of their own resources.

SCIENCE AND CULTURE has advocated forced march to Industrialization, Nationalization of Power and Fuel, Multipurpose Development of Rivers, establishment of scientific surveys, research laboratories, training of large personnel in scientific and technological work and development of educational facilities for all. It has preached unified development of India.

It has not forgotten the cause of the poor teachers and scientific workers who are niggardly treated. It has never hesitated to call a *fetish* by any other name than a *fetish*, and it has done so without fear of parties and personalities.

Ideal conditions for reaching our objectives are yet to come. Leaders have to forget some of the slogans with which they have mesmerized the mass mind which has to be cleansed of some of the dangerous superstitions with which they have been infected. Yet twelve long years impregnated with events have led the country to a new turn. The time is not far when the intellectuals and workers, men of science and men of culture in our country will no longer be treated as mere decorations but will be called upon to play their part in reshaping the country on the lines proposed by SCIENCE AND CULTURE.

SCIENCE AND CULTURE will remain the Forum for advanced thinking, mouthpiece of the best minds of the country.

With the onset of its thirteenth year of existence, SCIENCE AND CULTURE pledges to strive in order to outbid its past. Co-operation of all concerned is the primary factor for the future achievements.

MULTI-PURPOSE DEVELOPMENT OF INDIAN RIVERS

THE Interim Government of India have expressed their intentions of undertaking vast measures for the fullest possible development of the natural resources of this country for the benefit of the common man as soon as they can free themselves from the present political entanglements. They have reiterated their intention of utilizing the latest scientific and technical methods for this purpose. The thoughts and ideas evolved by the National Planning Committee* of the Congress during the dark days of 1938-42 are thus bearing fruit, and we may expect action to follow soon.

We welcome the revolutionary change in the outlook of the responsible members of the National Government and hail with delight Pandit Jawaharlal Nehru's speeches on Power Development, Dr Rajendra Prasad's insistence on utilizing the latest scientific researches and methods for increasing food supply by making collective use of land and water and the various schemes of industrial and commercial development. But while welcoming such measures, we shall be failing in our duty if we do not lay proper stress on the magnitude of the task before us and the difficulties in giving concrete shape to them.

Take for instance the development of Power Resources. The rivers are considered as the most convenient and the unfailing sources of power these days particularly in a country, like India, where large parts have no coal, and even where there is coal, it is limited in quantity. A number of rivers have been earmarked for this purpose. The case of the Damodar was considered first, followed soon after by the Mahanadi, the Kosi, the Tista, the Sone and several others. The light hearted way in which these schemes are flashed in the radio and the press, gives rise to the impression that the plans of development may be achieved almost overnight, only if the country agrees to them. Such light-heartedness is indeed fraught with grave consequences, for vested interests, and interested parties may induce the Government to take hasty decisions on premature plans.

True, a river properly trained is a source of unfailing hydel power. It may also be of immense social benefit. Speaking of river development (for the Tennessee) Lilienthal has emphasized :

"That the conversion of water resources into actual social benefits and the restoration and even increase of the soil resources can be achieved has been made manifest by scientists in the course of the past century. The scientific means are available to convert a silted, precipitous river, shallow in many places, deep in other, into a great stream navigable from its headwaters down to the Ohio, and thence, because of the connection with the Mississippi, down to the Gulf of Mexico with access to all parts of the world; to take the crest from the flood waters, which are a perennial threat and often a deadly danger to the cities on the river's banks, by regulating dams; and to convert the falling water into electric power, and to send it out in the service of mankind to a distance of 250 miles, and much further still by inter connections with other systems. Anticipating the exhaustion of the soil, science and its experts can apply the appropriate remedies. They can restore the depleted soil by the application of phosphatic food; they can correct the damaging agricultural practices of a single crop economy of cotton or corn; and by diversifying the crops both restore the soil and produce a higher standard of living. Special equipment can be devised to conserve the soil and farm difficult hill sides. And, with navigation and electric power and new agricultural practices, an industry supplemental to the valley economy can be encouraged, each different factor fitting into a balanced efficient pattern."

Such multipurpose developments have also been envisioned for our rivers. But let us consider how these developments are brought about, we mean, the stages leading up to the finalization of the schemes.

First Stage—Survey

The first stage may be termed 'Survey', a complete hydrological, geological, mineral, agricultural and forest-survey of the river-basin.

To develop a valley is to harness its water resources. To have a complete knowledge of the water resources one must know the average precipitation in the valley all over the catchment, the time of the year when rainfall is maximum and when it dwindles, the track of the rain bearing winds and the manner in which the rainfall is usually distributed over the area. Furthermore it is essential to determine what proportion of rain actually runs down the main stream and the tributaries (run-off) ; when they get swollen and the time of the year they run dry. A large number of *hydro-meteorological* stations and stream gauges operating for at least 10 to 20 years can supply us with data which may be helpful for the above information.

The water resources in a valley are developed not for their own sake but to provide power, facilities of transport for the development of the mineral, agricultural and forest resources of the terrain. One must have a thorough *geological survey* to ascertain the nature of rocks, their structure and suitability for construction purposes. The labours of the prospectors alone can furnish us with the estimates of minerals

* The National Planning Committee appointed two subcommittees for this purpose (1) The subcommittee on Power and Fuel with Prof. M. N. Saha as Chairman, (2) The subcommittee on River Training, Irrigation, etc., with Nawab Ali Yar Jung of Hyderabad (Deccan) as Chairman. Both these subcommittees made comprehensive recommendations for the development of Indian rivers and of water-power.

and ores, their quality and industrial possibilities. The agronomists working in co-operation with *foresters* for a number of years will know the type of soil management, needs of land utilization and crop rotation which may add to the agricultural and forest resources of the valley. These data form the basis on which all plans for development must be built. But have we got all these data for the rivers which are now prominently figuring in the Press? Our private investigations have shown that in most cases, we have absolutely no data. The Mahanadi project is causing a good deal of controversy, but Mr Bagchi*, in his learned article in this paper has shown how meagre is the data about this river. This huge basin which is larger than the Tennessee had only one stream gauge up to 1940, while the Tennessee is served by 700 stream gauges. Large parts of the basin have never been visited by geologists. Our considered opinion is that to proceed with any actual constructional schemes on such meagre data is tantamount to building on "Loose Sand". The same charge may be brought against many other rivers which occur prominently in the Press and are being used as 'slogans'

THE SECOND STAGE PLANNING

When a sufficient amount of these primary data as collected by the geologists, agronomists, foresters, chemists and hydrologists have been ready, the planning section should begin their work. As they proceed with their task the planners should indicate whether the surveys have been comprehensive and elaborate or need to be supplemented by fresh data. After the planners have got ready a complete blue print of the resource developments of the entire valley including the *tributaries* they should next fix upon the sites of dams, their capacity and height. To quote Herman Finer:

> "The construction of a dam is not merely the problem of pouring so many tons of concrete into the river at a given place. A comprehensive process of planning has to precede the decision *where*, *when*, and *how* to build. The multiple uses navigation, flood control, electricity and malaria control by fluctuation of the water level are in contest for the water of each and all the dams. The land which has to be bought may be very valuable for agricultural purposes; roads and railways may cross it, and cities and villages may be built on it. Hence, balance of the economy to be produced by the dam must be struck against the economic waste caused by the inundation, and a site may perhaps have to be reconsidered. This means careful adjustment of site and level of the taking line, with the aid of air mapping and stream flow prediction. In due order of time, the land must be surveyed and bought, and families and even churches and cemeteries relocated."

The function of the planning section may thus be linked to that of the architect in the construction of a large building. We have reasons to believe that except in the case of the Damodar, no proper planning has been done or possible in any other river. Sites appear to have been selected rather hastily, or on romantic grounds, and the valley as a whole has not been properly examined. One of the glaring errors appear to be to start with the main river first instead of first starting with the tributaries as has been accepted as a principle of the Tennessee.

The reason is obvious. The tributaries carry the water of separate areas, over which heavy rains causing floods is generally precipitated at different intervals, rarely during the same interval. When the latter event happens, there would be a disastrous flood on the main river basin, and any protective measure may be blown away. Such a calamitous condition may be far better controlled by having controlling dams on the tributaries, than on the main river, because the violence of the incidence is now distributed, instead of being concentrated. This fundamental principle appears to have been forgotten in the enthusiasm for river-development, for we are hearing only of dams on the main rivers (*e.g.*, the dam on the Kosi near the Varahachhatra, the dam on the Godaveri at Rampadasagar).

THE THIRD STAGE—DESIGN

Along with the planning, should proceed the task of designing of dams, power-stations, navigation locks, etc. In course of designing it might be necessary to have experimental solutions of certain problems, so that fully equipped *investigating laboratories* will have to be set up as the designing proceeds. In the U.S.A., such laboratory work can be carried out at several stations *e.g.*, at the Bureau of Reclamation Laboratory at Denver which has elaborate arrangements for carrying on model experiments, a thorough chemical and physical examination of the cement to be used for dam construction and the testing of new engineering plans. In India we have fortunately a few River Research Laboratories in Poona, Lahore and Calcutta where model experiment can be carried out. But there seems to be no place where investigations on cement can be properly carried out. This is a very important item, the urgency of which was brought home to U.S.A. Government when a large dam collapsed unexpectedly on account of bad quality of cement used.* After that bitter experience the U.S.A. Government insists that whenever a large dam is undertaken the chemical contents of the cement and the acidity and

* SCIENCE AND CULTURE, February, 1947, p. 348.

* Cement used in this dam contained about 1 per cent of alkali. The water of the river was acid which gradually acted on the cement and rendered the structure sievy, so that it ultimately collapsed.

alkalinity of water must be thoroughly tested. In addition physical strength of cement slabs should be tested and certified before they are allowed to be used. This aspect has never gone home to our organizations in charge of planning. They hardly seem to realize that all the above stages, from Survey through Planning and Designing right up to Execution require time and deliberation. In the Tennessee valley the basic data was provided as a result of 25 years of survey of the valley by the U.S.A. Army of Engineers. The knowledge gained thereby was the basis of Planning though it was not found to be sufficient, and had to be supplemented. This is not all. We are not also aware whether sufficient number of personnel are available in India for investigation purposes right at this moment. In Russia when the U.S.S.R. Government took the decision of developing their rivers on multipurpose basis they had opened up to 1930 not less than 5200 stream gauge stations to measure the discharge of streams throughout the country and mobilized the services of a huge army of geographers, hydrologists, geologists, agronomists and foresters. The number of stream gauge stations in the U.S.A. now amount to over ten thousand. India has river-systems carrying much larger volume of water, but the number of stream gauge stations will not be more than two to three hundred and most of that in the Punjab.

THE FOURTH STAGE CONSTRUCTION

The successful execution of the Plan and designing require a successful integration of the work and experience of the Civil Engineers, Irrigation Engineers and Electrical Engineers of all grades on a scale which had hardly been attempted in any previous human undertaking. Perhaps the magnitude and difficulty of the work will be brought home clearly from a number of relevant quotations from persons who have actually studied the works of the T.V.A. very deeply.

Commenting on the construction in the Tennessee Valley, Julian Huxley observes,

"The dams are the outstanding symbol of the great undertaking. To the engineers and architects they are the most exciting technical problems of the many which they have had to solve. . . . . . In all the structures, dams, and buildings there is a consistent logic and sensibility. This is due in large measure to the quality of technical personnel, but it could never have been completely achieved if the engineers and the architectural and site planning group had not, from the first, developed a mutual understanding of each other's aims and specific skills. Logically, the engineer was the dominant partner in designing the great dams and the architect in designing the many buildings of the great engineering structures. The correct placing of dams was the job of the Project Planning Bureau. Surveys of sites were made to determine optimum topographical and geological conditions; they were then checked against the nine foot channel requirement in the act. Dam heights determine flood storage levels in the reservoirs, and these were balanced against damage to communities, farm lands, highways and railroads. Power as a byproduct of flood control was considered in relation to the entire development as well as to individual dams. On the main river, as it passes through the plains, the nine dams are long and relatively low. On the tributaries the dams are shorter and relatively high. On all sites the first step in construction was to erect coffer dams.* On the main river, concrete for the structures was prepared in mixing plants on barges, 40 feet by 90 feet, which were moved as required. Sand and gravel from the river bottom was barged upstream to feed them. Gantry cranes swung the concrete from the mixing barges to the forms. 700,000 cubic yards of aggregate and 700,000 barrels of cement were used for the Wheeler Dam. At Norris a nearby hill furnished rock and sand for the concrete. From the quarry the rock was carried to the crusher, thence to the screening plant, the batching plant and the concrete mixers. One million cubic yards of concrete was hauled up on cable ways over the dam site at a rate of 3 cubic yards per minute."

Herman Finer tells us that

"The T. V. A. policy has been to take its own labour force and equipment from dam to dam, and work of a similar kind must be so scheduled that equipment and men may go on in due progression from one dam to another. This requires a continuity of operation and therefore a continuity of financing."

While speaking of construction it should be pointed out that the type of development on the main river may be of one type in all cases where as it would be altogether different in the case of the tributaries. In his Readership lectures delivered in the University of Calcutta, Mr Voorduin observed,

"The problem on the tributaries was different from that on the main river and the selection of projects was controlled mainly by considerations of flood control and regulation of minimum stream flow. Topography and geology at many sites were found to be generally favourable for the construction of dams, but the height to which dams could be built was limited in many cases by existing communities and facilities such as highways and railways . . . . The total usable controlled storage volume above minimum pool levels at all these dams amounts to about 8,600,000 acre ft. The total drainage area controlled by reservoirs on the tributaries is nearly two-thirds of the drainage area above Chattanooga the principal point of flood hazard on the Tennessee River. The total installed power capacity at the tributary plants is about 1,012,000 K.W. including 307,000 at the Aluminium Company's dams.

"The type of development constructed on the tributaries was determined mainly by the topography and geology of the site as well as the availability of materials at the site suitable for construction purposes. Because these conditions are different at practically all the sites on the tributaries, the only similarity which can be traced is in the spillway gates and powerhouse equipment and layout.

"In all the T. V. A. structures," he goes on to observe, "great economy was obtained by standardization of design. Hydraulic structures, generating units, mechanical equipment, gates, cranes and accessories were designed not only for the particular project under consideration but also to permit repeated use on successive projects."

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* Water tight inclosures.

Referring to the constructions Voerduin again emphasizes that

"These are large quantities and the amount of work involved could not have been achieved in such a short time if any detail had been left to chance. Time schedules were prepared for the design of each particular feature of each project, so that drawings would be available when needed, and similar schedules were made for preparation of equipment specifications, manufacture, delivery and erection of equipment; for procurement of construction materials and equipment, and for the construction operations themselves in their logical sequence. These time schedules were rigidly adhered to so that the time of completion of a particular project could be predicted with certainty many years in advance."

As is clear from the above quotations the T.V.A. had to develop its special technique of construction, sometimes investing new methods and training special personnel in its own institutions. The works which have been contemplated in India are vastly larger than the T.V.A. and it is redundant to add that unless we can integrate human efforts on the same line on this scale there is no chance of successful execution of any plan.

The Fifth Stage—Utilization

The last stage is utilization of the power developed for industrial purposes, utilization of the land reclaimed for agriculture and of the main river for navigational purposes. In this matter the valley authorities will have to come into frequent conflict with various vested interests, namely, power companies, industrialists, peasants, and possibly steamer and railway companies. The utilization of the resources developed cannot therefore be divorced from the plan.

To quote Finer,

"The most spectacular as well as the most important single resource is water power. The T. V. A. therefore applied itself to harnessing the existing water resources in the unruly Tennessee River. The river has been tamed by a system of gigantic dams; it has been made almost completely fit for navigation as part of some 5,000 miles of inland waterways, and its tendency to destructive flooding has been reduced. The waters that the T. V. A. caught and then spilled over a score of linked dams have been exploited to make vast quantities of cheap electric power, which has been distributed through non-profit-making municipal or co-operative methods. Especially valuable concentrated phosphatic fertilizer has been experimentally produced, and applied in widespread demonstrations, by means of which the farmers have been educated in better agricultural methods so as to increase their produce, diversify their crops and yet restore and conserve soil. Rural life has been rendered both agreeable and productive. The T. V. A. has shown steady and active concern for the region's forestry and mineral resources, for the promotion of agricultural and other industries and for the health and general welfare of the people."

Planned Survey

And for a scheme to initiate the above developments a planned survey is inevitable. Even at the cost of repetition we must again emphasize that an accurate and dispassionate survey alone can provide knowledge which would dictate action. For the Tennessee

"Even the basic survey of mapping had to be largely done by the T. V. A., which discovered on taking over in 1933 that there were hardly any maps of the area that were adequate for their purpose. Under a co-operative agreement with U. S. Geological Survey, a series of planimetric maps at 2000 ft. to the inch was completed by 1936 for the entire area, constituting a record for speed for such an enterprise. This was useful as a start but topographic maps (showing the contours) were also desirable, and the preparation of these, again in co-operation with the Geological Survey, was begun almost as soon as the planimetric series was completed; by now over a third of the valley has thus been mapped, with 20 feet contours over flat country and 40 feet contours in hilly terrain. In both cases the latest techniques of aerial photography have been employed."

There was also the division of soil survey attached to the U. S. Department of Agriculture which prepared elaborate soil maps which were so thorough that they "are models of what soil survey maps should be".

All these indicate therefore that the multipurpose development of rivers can be effected only through a definite procedure. The following are the steps in any scheme of development:

(1) Survey of the inherent characters of the land and the natural resources water, minerals, soil, vegetation.

(2) Planning on a multipurpose basis so that power, navigation, irrigation, land use and flood prevention are integrated in an efficient way.

(3) Design.

(4) Construction—systematic researches should be constantly taken help of for a sound construction of the plan.

(5) Utilization—An optimum utilization can be assured only on basis of a balanced development of the entire valley.

Let us now hope that after freedom has been achieved and we are free to shape our own destiny the leaders of the country will study the problem seriously and evolve a chain-work of organizations for river development which will achieve the desired end. We cannot afford to commit blunders like the Bombay Back Bay scheme and the Mundy hydro-electric scheme; that will be ruinous for the country.

REASON AND EXPERIENCE

S. K. MITRA

THE theoretical physicist and the experimental investigator each considers his own field of work more important than that of the other. This is but natural. The former is proud of his sublime ideas and looks down upon the soiled hands of the experimentalist. The latter, in his turn, ridicules the theorist as a 'paper and ink' man without any knowledge or appreciation of precise laboratory work. The average scientific worker, however, considers the contributions of the theorist and of the experimentalist as complementary, one helping the other, in the general progress of knowledge. Unfortunately, this healthy rivalry between theory and experiment has assumed an extreme phase in recent years. A school of scientist-philosophers of which the late Sir Arthur Eddington was the leader has arisen who ask if knowledge derived from experience can lead us to the knowledge of ultimate reality. They contend that instead of knowledge derived from experience, *a priori* knowledge, that is, knowledge inborn in our mind should be made the starting point for reasoning out the scientific laws. Because such knowledge being independent of all experiences, can claim a higher degree of certainty. They further maintain that for discovering the laws of Nature one has only to delve into ones own mind and that to a Master-mind well trained in mathematics and epistemology the laws reveal themselves without any appeal to experiment.

Eddington himself had attempted to deduce from what he considers epistemological considerations—two of the fundamental constants of physics, namely, the ratio of the mass of proton to that of electron ($M/m = 1836$) and the fine structure constant ($hc/2\pi e^2 = 137$). Indeed, according to Eddington such fundamental knowledge results from the constitution of our minds and he makes the following interesting remark in this connection: 'When science has progressed furthest, the mind has but regained from nature what mind had put into nature. We have found a strange footprint on the shores of the unknown. We have devised profound theories, one after another, to account for its origin. At last we have succeeded in reconstructing the creature that made the footprint, and lo! it is our own.'

A Priori Knowledge and its Rôle

There is, however, a school of equally eminent scientists who challenge this doctrine reminiscent of that of Kant, namely that a pure science of nature based on reason and *a priori* knowledge alone is possible. They maintain that constructs of pure reason, so far as the world of reality is concerned, is entirely empty; they are merely free inventions of human mind. And, until the gap that exists between the abstractions of epistemology—the only tool in the armoury of which is pure logic—and the experience of the phenomenal world is bridged, epistemology is left in the air. To speak of establishing any fact of science by epistemology alone involves a contradiction of terms. For example, the ratio of the masses of proton and electron has no doubt been derived from epistemological considerations. But the concepts of proton and electron are themselves fruits of experiment and theoretical deduction—the recognised method of science—and not of reason alone.

Again, a little consideration shows that what is called *a priori* knowledge—with which one starts to reason out the laws or the constants of physics—is not really so. Such knowledge is not inborn in our minds but rather ingrained in our minds by the terrestrial surroundings in which we are brought up. As an example the finite velocity of light may be considered. This appears to us now so natural that we are tempted to regard it as *a priori* knowledge. And, to derive from epistemological considerations the constants (M/m and $hc/2\pi e^2$) one may not hesitate to start with this postulate. But to a human mind ignorant of the results of the measurements on the velocity light there is no absurdity in regarding light as being propagated instantaneously like the effect of gravitation. In fact up to the seventeenth century even men like Kepler and Descartes considered that light requires no time for propagation. The finite velocity of light is thus a knowledge forced upon us by our experimental observations and cannot be regarded as knowledge inborn in our mind.

Further, most of the so-called *a priori* knowledge do not stand the test of *a priori* knowledge, namely that it must be true at all times and everywhere. For example, Kant and Descartes believed the following to be *a priori* knowledge: Space has three dimensions; the sum of the three angles of a triangle is equal to 180°; everything that happens is pre-determined by causes having fixed laws. We now know that these statements are not universally true. They are so only in our narrow terrestrial experience. In the larger world of astronomy for instance, where the scales of space and time measured are billions of times greater than those in our ordinary experience, space is found to be curved and the sum of the three angles of a triangle is not equal to 180°.

Similarly, in the minute world of atoms and atomic nuclei where the scales of space and time are billionth parts of those of every day world, events happen without cause. Further, Space and Time are not independent of each other; they are interlocked. It is more correct to speak of the space-time continuum as having four dimensions, than of space alone as having three dimensions. It is thus seen that what appears to us as *a priori* knowledge is not really so. It appears *a priori* because of our limited experience.

Very few people, therefore, now agree with this new doctrine of the scientist-philosophers that the laws of Nature can be found, even in principle, by a Master-mind or by a Super-intelligent being by pure reason starting from *a priori* knowledge. Instead, it is believed that the starting point must be the knowledge we obtain from experience—experience of phenomena occurring in Nature, as for instance, the movements of the stars, the annual cycle of seasons, or, experience of phenomena produced under controlled conditions in the laboratory. It is at the same time recognised that experience alone, whether obtained from nature or in the laboratory, cannot take us very far without the help of reason. Human mind sorts out the experiences, studies regularities in them, and thus guided discovers the laws underlying the regularities. These are called the Laws of Nature which by their very definition are such that all consequences derived from them by logical deduction must conform to our experience.

It should be emphasized at this point that the actual discovery of the grand laws of Nature is made by intuition by the mind of a genius, and not by any deductive reasoning. The latter yields at best the regularities in Nature (*e.g.* Archimedes Principle) which are quite different from the Laws of Nature. The basic laws and concepts can neither be proved nor can they be derived logically from the facts of experience. Only, the consequences derived logically from them conform to experience. If there be a single failure then it is not a law. Considered thus, the basic laws of theoretical physics may be regarded as free inventions of human mind. And perhaps in this restricted sense the new school of philosopher-scientists are right in maintaining that pure thought is competent to comprehend the reality.

The Simplicity Postulate

But, if the basic laws and concepts of Nature are free inventions of the human mind even in a restricted sense, then the question arises, how far do they represent the reality? Because it frequently happens that a genius of a later age invents an alternative law, the consequences of which agree with observations equally well. How then are we to know that our method of enquiry—experience, experimentation, deductive and inductive reasoning and intuition is leading us along the right path? The test is, as enquiry proceeds, as knowledge advances, the grand laws become fewer in number and simpler. According to Einstein in Nature is actualized the ideal of mathematical simplicity.

This simplicity postulate is extremely important and may be illustrated by an example. Every physics student is familiar with the famous laws of motion of Newton. Motions of all material bodies, be that of a cricket ball or that of the earth round the sun, are governed by these laws. But, these laws can be deduced from an amazing simple principle, namely that Nature abhors waste. It so regulates the path of the cricket ball or of the earth round the sun that the total *action* in course of the path is a minimum. If the cricket ball were to follow a path different from the actual one the total *action* would be greater. All consequences of the laws of Newton can be deduced from this simple principle known as *Principle of Least Action*. And, what is more important, this principle gives us a much deeper insight into the working of Nature than the Newtonian Laws.

There is also a similar principle for the case of light. The path of a ray of light, from air to water for instance, is ordinarily computed with the help of the laws of refraction. But it can just as well be computed by applying the principle of least time, which means that the light ray in going from one point to another chooses the path which would involve the least delay. Any other path will take a longer time and the light ray, like an intelligent being avoids it. These two principles discovered long ago have recently come to the forefront. The principle of least action is of wide applicability covering the entire range of physics including that of the atoms and sub-atoms. Further, the two principles, the principle of least action, and the principle of least time have helped in the formulation of the system of mechanics known as Wave Mechanics used for studying atomic and sub-atomic phenomena. Which of the laws then represent more nearly the reality? The Newtonian laws or the Principle of Least Action? The laws of reflection and refraction or the Principle of Least Time? We say that the last named ones perhaps approach the reality nearer because they are simpler, fewer in number, are more broad based and are of wider application.

The idea that human mind can produce knowledge *a priori* has its origin in the geometry of Euclid which is a marvellous accomplishment of pure reason, the assertions following one after the other with absolute rigour admitting of no doubt. But this miracle of a logic system acquires the status of

a physical science only if it is conceived of as the science of the possibility of relative placing of rigid objects in space. The fact that pure reasoning cannot tell us anything of the reality regarding the world of perception was recognised first by Galileo two millenniums after the days of Euclid. And, the stagnation of science from the days of Greek philosophy to the middle ages is to be attributed to the excessive veneration paid to thought and abstract reason as opposed to observation and experiment. It may therefore seem strange that attempt should be made in the twentieth century to revive this worn out idea. In this connection the very apt remarks made by Max Born may be quoted: 'There is no philosophical high road in science with epistemological sign posts. No, we are in a jungle and find our way by trial and error, building our road behind us as we proceed. My advice to those who wish to learn the art of scientific prophecy is not to rely on abstract reason, but to decipher the secret language of Nature from Nature's documents, the facts of experience'.*

* *Experiment and Theory in Physics* (Cambridge University Press, 1944), p. 44. The reader interested in the subject is also recommended *On the Method of Theoretical Physics*, the Herbert Spencer Lecture, 1933 (Clarendon Press, Oxford), by Albert Einstein.

INFLUENCE OF EAST MEDITERRANEAN REGION FLORA ON THAT OF INDIA*

D. CHATTERJEE,

ASSISTANT FOR INDIA, ROYAL BOTANIC GARDENS, KEW, SURREY, ENGLAND

THE flora of India was for a long time believed to be a composite one being a mixture of Malayan, Chinese and North Asiatic floral elements. The main supporters of this view were J. D. Hooker and C. B. Clarke. This is partly true when we consider the vegetation of the great Indo-Gangetic alluvial plains where there is very little to suggest an indigenous vegetation. But it is impossible to overlook a distinct flora of South India and the Himalayas. For the purpose of a phytogeographical analysis, Burma is also to be considered a part of India although as is to be expected the southern part has a natural alliance with the Malay Peninsula and the North East with South West China.

It was established by the present author that India[1] has a flora of her own and of the total number of plants no less than 62 per cent are endemic and only about 38 per cent were originally foreigners and now naturalized in the country. India is a country with land connections, north and west and with a large peninsula projecting south in the Ocean. Such a Country may be compared in a restricted sense, with the Iberian Peninsula, Italy and the Balkan Peninsula. But from the number of endemic contents India may be regarded as very distinct and compares well with some isolated island like New Zealand (with 72 per cent endemics).

The land connection of one country with another supported by a more or less uniform climatic conditions tend to distribute plants from one another, and *vice versa* by the natural processes of plant distribution. Such a process viewed through thousands of years of geological time increases the range of distribution of many species, and gradually decreases their corresponding endemic nature. Such a land connection existed between Western Asia and Southern Europe and migration of fauna and flora has taken place. An attempt is made here to analyze partly this invasion of the Flora of East Mediterranean region into India through Palestine, Persia and Afghanistan.

The countries surrounding the eastern basin of the Mediterranean sea and part of West Asia played an important part in the past in the distribution of fauna and flora in Europe and Asia. During the middle Miocene the Balkan peninsula was a part of Western Asia and not of South Europe. Even in the Quarternary period the Aegean sea area was still land and the Balkan peninsula was like an isthmus joining Europe with Asia and separating the Black sea from the Mediterranean. By further change the Aegean area went down and the present configuration of the Mediterranean region was formed. The distribution of fauna and flora in this area was subject principally to two types of climate, *viz.*, (*i*) the dry desert belt stretching from Sahara across the Arabian peninsula and Iraq, and (*ii*) a subtropical climate running from Turkey, Persia to Afghanistan. Part of the first dry region is known as the Eremian region.

* Full text of a talk given at a meeting of the Systematics Association, held at the Royal Botanic Gardens, Kew, on October 5, 1946. (See *Science and Culture*, February 1947, p. 383 and *Nature*, October 19, 1946, p. 535).

[1] *Journ. Roy As. Soc. Bengal* (Science), 5, 1, 1940.

The present floras of the countries surrounding the eastern end of the Mediterranean region have been studied and worked out by persons like Boissier,[2] Post,[3] Blatter,[4] Halacsy,[5] Turrill[6] and Muschler.[7] A flora of Persia is now in preparation in the Kew Herbarium by Dr .Parsa of Teheran. There is no comprehensive flora available of Afghanistan except Col. Aitchison's paper[8], and a list of Beluchistan plants is also available.[9]

The absence of a comprehensive flora of Afghanistan is indeed unfortunate. The geographical position of the country is such that much valuable information could be expected when the flora of the country is known. It will serve as a link between Western Asia and Orient on one hand and India on the other. Vavilov made an expedition in Afghanistan[10] in 1924, but he mostly concentrated on agricultural crop-plants and fruit trees as well as their water requirements and irrigational problems. It could be only emphasized here that the flora of Afghanistan should be compiled soon through the help of the Afghan Government and such a work would be very valuable from botanical, geographical and phyto-geographical points of view.

This eastern Mediterranean area is designated under different names. It is generally known as "Orient" in plant geography, but the term is used in quite different sense by zoologists. During the recent war another term "Middle East" was used to denote this area and this term gained considerable popularity during the last few years. For the purpose of the present analysis the area is thought better designated under the older terms of "Orient", an area best covered by Boissier's Flora.[2]

A study of the flora of these regions and examination of representative collections in the Kew Herbarium shows that certain plant families have their best development in the Eastern Mediterranean region which may also be regarded as their original home. From this area by natural processes, migrations have taken place both east and west, and the number of migrants are thinner and lesser and directly varies with the distance from the main source. On a very broad basis it could be said that families like *Cruciferae*, *Caryophyllaceae*, *Capparidaceae*, *Fumariaceae*, *Boraginaceae*, *Rosaceae* (partly) and *Labiatae* (partly) had their origin in the "Orient" area. The number of species in *Cruciferae* in some of the representative areas are as follows:—

Balkan Peninsula	Syria Palestine Sinai	Persia	Arabia	India
344	280	274	107	174 (45)

On the basis of approximately equal area the figure for India should be reduced from 174 to about 45, as shown by the second figure within bracket. These figures show that as we go further and further from the Balkan regions the number of species becomes smaller and smaller. This fact supported by the past geological history of Western Europe and the occurrence of a set of common plants in all the above countries leads to the conclusion that so far as India is concerned the family *Cruciferae* as a whole should be regarded as migrant from East Mediterranean region. Some of these common plants which are found from Orient to India are as follows.—*Mathiola odoratissima*, *Nasturtium officinale*, *Cardamine impatiens*, *Farsetia Jacquemontii*, *Farsetia aegyptiaca*, *Europhila vulgaris*, *Malcolmia africana*, *Sysymbrium Wallichii*, *S. Sophia*, *S. Irio*, *S. Loeselii*, *Erysimum repandum*, *Brassica Tournefortii*, *Moricanda arvensis*, *Capsella bursa-pastoris*, *Lepidium latifolium*, *Neslia paniculata* and *Fortuynia Aucheri*.

A large number of "Wides" in *Cruciferae* as stated above exists but there are a number of endemics too in India. These endemics may be regarded as of comparatively recent origin and not of "relict" type. By this explanation the theory of migration of the family from the Orient as proposed here remains unaffected.

Dr Turrill (*loc. cit.*, p. 379) has shown that no fewer than 400 species are common between Western Asia (Asia Minor) and the Balkan peninsula. A similar analysis of the Persian flora with respect to Turkey and Egypt on one hand and Western India on the other would yield figures which would be both valuable and interesting. A large number of species would be found common specially in families like *Cruciferae*, *Caryophyllaceae* *Boraginaceae*, *Rosaceae*, *Labiatae*, etc. This could not be done unless the flora of Persia is completed.

The family *Caryophyllaceae* too has developed best in the Mediterranean region. It is represented by 418 species in Balkan Peninsula with such large genera like *Dianthus* and *Silene* with 101 and 103 species respectively. The corresponding number of *Caryophyllaceae* in a vast country like India is only 107 which could be reduced to 25 on the basis of

[2] Flora Orientalis (1867-1888).
[3] Flora of Syria, Palestine and Sinai (Rev. ed.), 1932
[4] Flora Arabica—*Rec. Bot. Surv. Ind.*, *8*, 1919-1933.
[5] Conspectus Florae Graecae, 1901-12.
[6] Plant life in Balkan Peninsula, 1929.
[7] Manual Flora of Egypt, 1912.
[8] *Trans. Linn. Soc.*, Ser. *2*, *3*, 1-140, 1888.
[9] Burkill—Plants of Beluchistan, Calcutta, 1909.
[10] Agricultural Afghanistan Suppl., *33*. *Bull. Appl. Botany, Leningrad*, 1929.

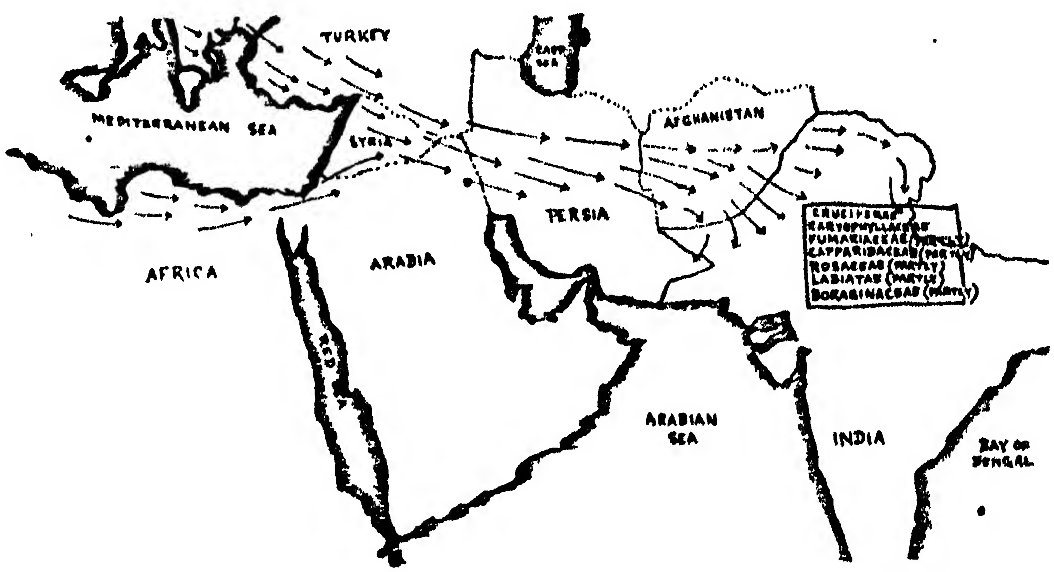
equal area perhaps even less. Some of the species common to India and western Asia and Orient are as follows.—*Dianthus caryophyllus D. fimbriatus, D. crinitus, Silene inflata, S. conoidea, S. arenosa, Lychnis coronaria, L. apetala, Carastrium trigynum, C. dahuricum, C. vulgatum, Stellaria aquatica, S. bulbosa, Arenaria serpyllifolia, A. holosteoides, Drymaria cordata* and *Polycarpaea spicata.*

Genera like *Hypecoum, Fumaria* and *Dicentra* in *Fumariaceae* seem to have come to India from the west although the large genus *Corydalis* is undoubtedly one of north Asiatic origin.

Examination of genera in *Rosaceae* and *Labiatae* in India shows that some of the genera have very strong affinities with the 'orient' and may have well migrated from that area It must be admitted that the family *Rosaceae* as represented in India has two centres of origin, some genera have originated in Western China while others like *Prunus, Rubus, Rosa, Cotoneaster,* and *Pyrus,* had their origin in Western Asia. Plants have migrated from both these centres into India by the west and eastern route by way of Afghanistan, Kashmir and North Burma and N. East Assam respectively.

and subsequent naturalization. These 38 percent could be sorted as :— (i) Species of very wide distribution in Asia and Europe, (ii) Weeds of cultivation and other introduced weeds, specially a number of species from South America, and (iii) Species of limited distribution in India and the surrounding countries.

The first two groups may be jointly and on very general considerations assigned to represent 8 to 10 per cent of the above figure. The third is more important group and plants have invaded into India from Malay, China and Western Asia. The invasion from the North is not very acute as many North Asiatic species found it difficult to cross the great roof of Tibet and the very high hills of the Himalayan mountains in their move for the plains of India. These two regions acted more or less like barriers against plant migration. It might be assumed that approximately 10 percent of Indian Flora have come from the West or "Orient" area and almost equal proportion respectively from the Chinese and Malayan side which makes up the total to 30 percent and with the addition of 8 percent wides of the first two groups mentioned above the figure 38 per cent



In *Labiatae* genera like *Origanum, Salvia, Nepeta, Stachys, Phlomis* and *Teucrium* had their origin in East Mediterranean region and have found their way into India through the west.

Conclusion

It has been stated earlier that 38 percent of Indian plants are "Wides" and their occurrence in the country is by invasion from foreign countries for all foreigners could be arrived at. It is admitted that these are very rough assumptions and may have to be changed on further critical examination.

For the present we might assume that 10 percent of Indian flora is of East Mediterranean origin or type, and this is expressed best by the above map. This view has further support in the fact that the majority of the families shown in the map have concentrated mostly in North West India.

U. S. BUREAU OF MINES AND ITS WAR-TIME PILOT PLANTS

C. C. MITTER,
MINT, BOMBAY

DURING a recent visit in U. S. A., the writer was given the opportunity to get acquainted with some of the activities of U. S. Bureau of Mines specially with regard to the utilization of many of its indigenous raw materials which were so long considered to be economically unimportant. With the declaration of war the State Government decided that as a part of the National Defence Programme, U. S. A. should be made, as far as possible, independent of foreign import. The Bureau of Mines was entrusted with the task of execution of research programmes in regard to the utilization of low-grade ores. All the field stations of the bureau which are spread all over the country took active part in this enterprise.

The head-quarters of the U. S. Bureau of Mines is located at Washington D. C. It is one of the modern State buildings in that capital city, commodious, lavishly equipped and furnished in the best American tradition. The head of the bureau is the Director who is assisted by a body of experts in all branches of subjects under its control. Most of these experts have extensive experiences in one or more of the field stations before they are transferred to head-quarters to act as advisers to the Director.

The Bureau is a remarkably efficient institution which keeps the State Government informed of the position of Mineral Industries within the State and its relation to the World mineral and metallurgical trade and industry. It has several field stations where experimental and research work on minerals found around the neighbourhood are carried out with a view to help both State and private industrial enterprise. The Bureau issues regularly -

1. Bulletins and Technical papers,
2. Economic papers,
3. An Annual Report of the Director,
4. Miner's Circulars,
5. Schedules,
6. Reports of Investigations,
7. Information Circulars,
8. Periodical Reports,
9. Mineral Market Reports,
10. Accident Statistics,

and 11. Co-operative publications.

Bulletins and technical papers present the results of scientific and technical investigations. Economic papers are analytical studies of production statistics, sources, resources, distribution and industrial flow of mineral commodities. The annual report entitled "Minerals Year-book" includes chapters, some of which are also published separately, on the production and consumption of metals and of non-metallic minerals. Miners' circulars present material used in Bureau first-aid and rescue courses. Schedules outline the procedure for testing materials or equipment to determine their permissibility for use in coal mines, etc. Reports of investigations are short papers which present the principal features and results of minor investigations or of special phases of major investigations. Their function is to make available quickly to the industries and the public the outstanding results of original investigative work by the Bureau. Information circulars are also short papers, essentially informational. They include compilations, reviews, abstracts and discussions and do not as a rule represent original investigative work. Their chief purpose is to present to the mining industry the principal facts on subjects of interest in a concise form suitable for sending out in reply to inquiries received by the Bureau of Mines. Periodical service reports give data on the status of the market for various minerals and include monthly bibliographies of literature on geophysical prospecting. Mineral market reports are brief statistical reviews issued annually. Accident statistics give summary figures, by States, for fatal and non-fatal injuries and man-hours worked in mineral industries. Co-operative publications present the results of investigations conducted co-operatively with various agencies. These reports and papers have been written either wholly or in part by members of the Bureau and published otherwise than by the Bureau or by Journals of various technical societies or by the technical press.

Well equipped museums are also maintained by the Bureau not only at its Head Quarters at Washington D. C. but also in the field stations.

During my visits to its field stations, the operations of the following pilot plants were noted.

(a) Electrolytic Manganese Plant for the production of high purity manganese.
(b) Titanium Plant.
(c) Electrolytic Chromium Plant producing chromium from lowgrade chromite.
(d) Plant for the manufacture of manganese dioxide from low-grade manganese ore.
(e) Alumina Plants (two) for treatment of low-grade alumina or clay.

The electrolytic manganese plant is described here in somewhat detail because the process of its

manufacture and its use was not only novel but also was the outcome of a very painstaking research in the field of electro-metallurgy. It has an additional interest because of India's abundant resources of manganese ore. In the remaining cases flow sheets are given indicating briefly the steps that are necessary to gain the final product. The chemical reactions involved in the processes are well-known but the plant equipments are interesting and elaborate. They are not only labour saving but also in some cases ensures purer products and a smooth continuity of the process itself.

Electrolytic Manganese at Boulder City Experimental Station of the Bureau of Mines, U. S. A.

This pilot plant has now a daily capacity of 1 ton and was erected at a cost of 2 million dollars. The object of erecting a pilot plant on a practically semi-commercial scale and at such a huge cost was explained thus

(1) As direct operating cost in a small scale operation of plants for electro-winning base metals from ores which require heavy capital outlays per ton of daily capacity bears little relations to that in the case of large scale operations, it was felt necessary to embark on a fairly large size pilot plant to the industrialists that the unit cost of daily output is reasonable.

(2) The experimental plant was expected to supply electrolytic manganese for important war uses, such as magnesium alloy bomb casings, when commercial production was not adequate to supply minimum war requirements.

(3) The plant was expected to supply electrolytic manganese for full scale tests in co-operation with industrial users of manganese which were mainly steel producers of U. S. A.

The total output of the Boulder City plant[1] from November, 1941 to November, 1944 was about 500 short tons.

The Electro-Manganese Corporation of Knoxville Tenn, the principal industrial producer of electrolytic manganese went into production in 1939 and has produced a total to January 1, 1945, of 8,647,250 lbs. and current production was reported stable and continuous at the rate of 275,000 lbs. monthly. The current rate of production of electrolytic manganese in U. S. A. is about 5 tons daily.

The plant contains four units,

(1) Crushing and Grinding unit,
(2) Roasting unit,
(3) Leaching and Purification unit, and
(4) Electrolysis unit.

The building housing these units have standard structural steel frames covered with corrugated iron.

The process used is shewn in the flowsheet.[2]

Ore is delivered to the crushing plant by trucks into a wooden bin through a grizzly. Oversize ore is broken through the grizzly by hand. Crushing is accomplished by a jaw crusher and rolls in closed circuit with a vibrating screen. An inclined belt conveyor delivers the crushed ore to the hydro-metallurgical building, where a Jeffrey vibrating conveyor distributes it to any of ten 5-ton steel storage bins. From the storage bins, the ore is weighed in buggies and fed to a Hardinge thermal ball mill equipped with an air classifier, where it is ground dry to 35-mesh.

The ground ore is fed to a 10-hearth, 5-foot-diameter Skinner furnace containing four muffles, where the manganese dioxide is reduced to manganous oxide to make it acid soluble. A reducing atmosphere is maintained in the furnace by dropping oil into the seventh hearth. The reduced ore or calcine is dropped into a Baker cooler revolving in water where it is cooled below 50°C. before being exposed to the atmosphere. The calcine is conveyed to a 10-ton storage bin.

Calcine is leached in 3,500 gallon batches with spent electrolyte from the cells containing 13 grams manganese, 130 to 135 grams ammonium sulphate and 29 to 30 grams sulphuric acid per litre. Brick-lined tanks containing turbine agitators are used for leaching. Make-up sulphuric acid is added to the leaches as needed. Calcine is added to the leach until a *p*H of 2·5 is reached and the leach is then neutralized to *p*H 6·5 with ammonia gas. A 95 to 96 per cent extraction of the manganese is obtained. After the leach is completed it is pumped to a 25 feet thickener. The spigot from the thickener goes to a series of five countercurrent manganese and ammonium sulphates and then pumped to the tailing pond. The overflow from the primary thickener contains metallic impurities such as As, Mo, Ni, Cu, which must be removed before the solution can be electrolyzed. The overflow passes by gravity into a Turbo-absorbed tank, where hydrogen sulphide is added. The metallic impurities are precipitated as sulphides and removed from the solution by filtration on an acid-proof Shriver filter press. The filtrate is stored in a lead-lined tank.

The solution after purification with hydrogen sulphide is essentially free of metallic impurities but contains colloidal sulphur and colloidal metallic sulphides, which are removed by the addition of 0·152 gram of iron per litre of solution as ferrous sulphate, followed by oxidation and precipitation as ferric hydroxide. The ferric hydroxide precipitate absorbs the colloidal material and also removes any arsenic or molybdenum that might still be present.

The oxidation of iron is carried out continuously in a series of three Turbo-Absorbers. After the iron has been precipitated, the solution is allowed to age in a storage tank several hours before filtration on a stainless steel filter press. The filtrate is now free of all materials harmful to electrolysis and is stored in a lead-lined tank and drawn into the cell room as needed. The purified solution contains 35 grams manganese and 130 to 135 grams ammonium sulphate per litre.

The cell room in the plant contains eight cells. The cells are made of wood and lead-lined, and have a capacity of 22 anodes and 21 cathodes. The anodes (8" × 16" × ¼") are lead containing 1 per cent silver and 0.5 per cent arsenic, they are perforated so as to be 40 per cent void. The cathodes (42" × 22" × 16" gage) are type 316 stainless steel. A copper conductor bar is rivetted and brazed along the top of the cathode. The cells contain a false bottom, which serves as a reservoir for the manganese oxides that form at the anode and spall off periodically. A canvas diaphragm covered frame surrounds the anode. A diaphragm cell is necessary to prevent the acid at the anode from mixing with the solution surrounding the cathodes, which has a pH of 8.2 to 8.4. The manganese concentration of the catholyte is 13 grams per litre and since the feed solution is 35 grams manganese per litre the manganese "strip" is 22 grams per litre. Sulphur dioxide (0.1 gm. per litre of solution) is added to the feed solution as it flows into the cell room. Direct current for the cells is obtained from Ignitron mercury-arc rectifiers. A cathode current density of 45 amps. is maintained and a minimum current efficiency of 60 per cent is obtained. The cell voltage is 5.3 volts. The cathodes are removed from the cells individually every 24 hours and after dipping in dichromate solution which prevents oxidation of the manganese, and washing the deposited manganese is removed by flexing or striking with a rubber mallet. The small quantity of manganese that remains on the cathode after stripping is dissolved in acid. The stripped cathodes are washed and dipped in a sodium silicate solution, followed by another wash. They are then ready to be used in the cells again. The sodium silicate treatment leaves a very thin film on the cathode surface, which aids stripping. Every second day the cathodes are a buffed before the silicate treatment. The buffing maintains a highly polished surface which aids stripping.

After a cell has operated for 6 weeks, it is shut down and cleaned, and the canvas diaphragms are replaced. The manganese oxide sludge in the bottom of the cells is returned to the reducing furnace.

The temperature of the cells is maintained at 35°C. by cooling coils along each side of the cell, through which cold water is pumped from an induced draft spray tower.

Spent electrolyte from the cells flows by gravity to a mixing tank in the leaching plant where ammonium sulphate suffiecent to make up losses is added. The solution then flows to a series of four cooling tanks where it is cooled to below 20°C. by cooling coils containing cold water from a spray tower. As the solution becomes chilled, a complex sulphate containing 4 to 5 per cent manganese, 4 to 5 per cent magnesium, 34 to 36 per cent ammonium sulphate and 28 to 30 per cent water crystallises out.

The sulphate crystals are separated from the solution in a Bird continuous centrifugal filter. Removal of the complex sulphate is necessary to keep the magnesium concentration down to the point where the complex sulphate will not crystallise anywhere else in the plant circuit. The crystals have a potential market as a fertilizer and, if sold as such, are dried in a low temperature rotary drier which removes the water of hydration.

An over-all 88.2 per cent recovery of manganese from the ore is made, with the losses distributed as follows:

> Crushing 1 per cent, grinding 1.08 per cent, roasting 0.07 per cent, leaching and washing 3.67 per cent, hydrogen sulphide purification 0.40 per cent, electrolysis 0.88 per cent and magnesium removal 2.00 per cent.

Purity of the Electrolytic Manganese and Scope of Its Uses.[4] The average analysis of impurities in electrolytic manganese produced in the Boulder city pilot plant is

Cu	0.0004%	Pb	0.001%
Fe	0.0025%	Ni	0.0025%
Sulphate S	0.0025%	Mo	0.002%
Total S.	0.026%	As	0.0005%
C.	trace	H_2	0.010 to 0.015%

As manganese in the form of low-phosphorous, low-carbon ferro-manganese containing 0.10 to 1.00 per cent carbon (max.) and 0.20 per cent phosphorous finds extensive use in steel industry investigation was principally directed to determine the possible advantage of electrolytic manganese resulting from its almost complete absence of phosphorous and carbon. This single factor was considered enough to offset the slightly higher cost per unit of manganese than low-phosphorous, low-carbon ferro-manganese. The entire field of work in this connection has been entrusted to R. T. C. Rasmussen, Senior Metallurgist, Bureau of Mines, U. S. A., who worked in co-operation with the steel manufacturers of U. S. A. and his report (R. I. 3829, October, 1945) on the acceptability of electrolytic manganese to the steel industry was submitted by the Bureau at Nevada for hearing of the Mining and Minerals Indus-

try Sub-Committee of the Special Committee of the Senate which was set up to study "Problem of American Small Business".

Scope of its use in other spere is under investigation. The Bureau of Mines has been engaged in a systematic study of the copper-Mn, Mn-Cu-Ni and copper-Mn-Zn system. Previous work on these alloys was deemed to be fragmentary and based as it was on alloys with impure grade of manganese with significant quantities of iron, silicon, aluminium and carbon as impurities. These impurities are known to affect equilibrium conditions; it thus became desirable to re-examine these alloys made from pure metals. Recent patent literature shows description of many interesting manganese alloys made from high purity manganese having such properties as having high modulus of elasticity, high co-efficient of expansion, efficient and remarkable vibration damping capacity.[5, 6, 7, 8]

PILOT PLANT FOR THE PREPARATION OF MnO_2 FROM LOW GRADE MANGANESE

Field Station Boulder City, U. S. Bureau of Mines

Manganese Ore

Treated with SO_2 & Calcium Dithionate

Product—Manganese Dithionate Slurry

Collected in filter bags and extracted with water on counter-current principle

Manganese Dithionate in Solution

Silica (Residue)

Treated with Lime

PPT MnO_2

Filtrate Calcium Dithionate (Regenerated)

Fe

Ferro Manganese

Diagrammatic Sketch of the Process.

Procedure.—Poor quality of Manganese ore is treated in cold in a row of three iron stills arranged in cascade with calcium dithionate solution in an atmosphere of sulphur dioxide. An exothermic reaction takes place with the formation of manganese dithionate. At the end of the reaction, the reaction product is discharged into filter bags placed in the first series of three tanks full of water. The tanks are arranged in such a way that the overflow from the third tank is discharged into the second, and the overflow from the second to the first. After a certain period of time during which maximum extraction of manganese dithionate from silica etc. in the first tank where the fresh discharge of the slurry from the stills is consigned in filter bags removed to the second and finally to the third. The concentrated manganese dithionate solution which is constantly emptied out from the first tank by means of a pump is discharged into a tank where it is treated with just enough lime to precipitate manganese dioxide and regenerate calcium dithionate. It is filtered, the dithionate is brought into cycle and the manganese dioxide is used mainly to prepare ferro-manganese.

[Pilot Plants for the preparation of Titanium and Alumina will appear in the next issue of the Journal.]

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HYDROLOGY IN INDIA

K. BAGCHI,

[illegible] SCHOLAR, CALCUTTA

THE conservation of the water resources and their proper utilization require a thorough knowledge of the hydrological conditions in a country. Hydrological data are needed equally in big multipurpose projects as well as in minor irrigation works. Countries like France, U. S. A., Russia and Sweden, that made considerable progress in harnessing their water resources for various purposes have had always depended on sound data collected over a number of years.

In India, we have hardly anything to compare with the thoroughness and sufficiency of data collected in the countries mentioned above. In the case of the Indian rivers, records of discharges and fluctuations of level are recorded only in those areas where irrigation canals have been taken from them or where road and railway bridges will have to be protected from sudden breaches. Fluctuations of subsoil water table are in record in the irrigated lands of Sind, the Punjab and U.P. But in modern methods of river training large tracts, like entire river basins are considered as individual units, so that extremely localized information or too wide generalisations do not provide a correct estimate of things.

In making an estimate of the water resources, the first requisite is to ascertain the total precipitation over the area. Such wide tracts as the basins of the Kosi, the Mahanadi or the Tista for example cannot have uniformity of rainfall. A large number of rain gauging stations distributed according to the locus of storms and the topography would be needed. The records gathered from the large number of stations thus distributed will help us to calculate the total water to be dealt with as also the rain over individual sections of the catchment. Equally important is to ascertain the proportion of the total precipitation that ultimately escapes through the main channel in its different sections as also the various tributaries. This is done by stream gauges. Speaking of rainfall and stream Ganges Frv and Chowalter observe:

"The engineers must gather, at least daily, sufficiently complete information regarding drainage basin so that they can estimate with considerable exactness the volume of water that is flowing and will be flowing for several days in all the principal streams throughout the watershed. To accomplish this requires a comprehensive network of rain and stream gauge stations.

This network is basic in the success of the hydrological phases of the water project operation. The extent of the network of rain gauges will vary with the size and topography of the drainage area. In general, in mountainous regions where variation in rainfall are most pronounced, the number of stations per unit area must be greater than in flatter countries where geographic influences are not so important. In water project operations, as in other hydrologic the smaller the area of interest, the larger the number of rain gauges required per unit area.

In the entire Tennessee Valley the density of rain gauges is one to each 86 sq. miles. In the mountainous eastern section, the square mile per gauge approximate half the average, and in the rolling western portion of the basin at lesser elevation, the density is about 130 sq. miles per gauge. The net work includes sufficient recording rain gauges so that intensity and duration of storm rainfall are known. Gauges are located with respect to topography so that rainfall at high as well as low altitudes is measured."

It is exactly on the last point that Indian conditions differ from that in the Tennessee. From records of the meteorological department it appears that there are some three thousand rain gauging stations under its direct supervision. Some more stations are also owned by the agriculture, irrigation and forest departments as also the Indian States, but unfortunately records of these stations are not available in a ready form. All these stations were set up at a time when the present scope of hydrological possibilities were not realized in India and naturally therefore these stations are not distributed on basis of topography and other considerations. Most of the stations for the different river basins are located in the lower plains and deltaic areas where they are needed by the farmers. But the effective portions of the upper catchments that usually determine the precipitation and run off in the river are almost unrepresented. In the case of the upper catchment area of the Kosi we have heard up to now only one rain gauge station whereas the number of square miles per rain gauge in the Mahanadi catchment is 784·6 as against 86 in the Tennessee.

The story of stream-flow records is even worse. For the entire Mahanadi there is only one station at Naraj, so is with the Damodar at Rhondia. Streams like the Kosi, Tista and Brahmaputra have none at all. For none of the rivers do we possess any data regarding run off, mechanical and chemical load as well as stream behaviour under varying conditions.

Our attention has recently been drawn, thanks to the Geophysical Committee of the Interim Government of India, to the Snow Survey and its bearing on conservation of water. At its invitation, Dr J. E. Church, President of the International Commission of Snows and Glaciers came down to the Himalayas last summer to lay the foundations of a Snow Survey system. The expeditions led by him confirmed the

existence of abundant snow water along the heights of the mountain up to an elevation of about 10,000 ft. which ultimately find their way to the different streams *e.g.*, the Tista, Kosi, etc. The study of the precipitation of snow and its quantity from year to year is therefore of equal interest to us in regulating the Himalayan streams, as are the rains.

Dr Church has indicated the layouts of the snow survey stations and has taught the procedure of depth measurements and percentage calculations of the snow cover. He holds:

"The factors affecting the forecast are few. The basic preliminary requirement is the maintenance of fixed snow courses with fixed points of measurement. All courses should be long enough and numerous enough to provide a reliable average. Accuracy of stream measurements is equally important. Unless based on a long period the normals for snow cover and stream flow should represent the same series of years. The chief distorting factor is the possible divergence from normal of the precipitation during run-off, for normal precipitation during run-off is essential in keeping the snow fields up to the percentage set by the Snow Survey."

The extent and depth of snow accumulation above the perpetual snow line is also found to have a considerable influence on the onset of the monsoons and the quantity of rains available from them. The snows, in all horizons, need careful investigation so that their role in hydrology can be thoroughly realised.

There are also provinces in India like the N.W.F.P., Baluchistan and parts of Rajputana where surface flow of water is so scanty and drought so frequent that the question of conservation cannot arise. On the otherhand, these regions are provided with sub-terranean flows of water that can be tapped at varying depths. It is being tapped even now either through deep wells as in Rajputana or through the *Kerez* system as in Baluchistan. The sub-soil water in these parts therefore plays as important a role as the surface water elsewhere. Study of the quantity, depth and fluctuation of the sub-soil water supply should also be included under hydrological investigations. It is not in arid countries alone that the study of ground water table have their importance. Areas given to intensive cropping are also found to be affected by fluctuations of sub-soil water. Heavily irrigated lands in Sind, Bombay, Madras, etc. have their own methods of recording fluctuations in water table. Long tubes are driven in the ground and rise and fall of water in them indicate the relative position of the water horizon.

It is also necessary to have an analytical record of the dissolved minerals, the suspended particles and the bacteriological conditions of the water used. The acidity or alkalinity of water, for example materially affects the structures of storages, sometimes making them leaky. Water for industrial uses and for drinking purposes should also be examined against harmful complications. The amount of suspended load in the water (of a stream) indicates the extent of soil erosion in the catchment and this should also be insured against.

In making estimates of water needed for a particular purpose, say irrigation or water supply, one should also know the loss that may occur through percolation underground or evaporation from the surface. The size and capacity of the reservoirs will have to be planned accordingly. Necessary provisions will therefore have to be made to record these in hydrological investigations.

For large scale undertakings and comparisons the data collected from the different stations should be of the same standard and quality. For this purpose in almost all progressive countries there are Hydrological Bureaus especially entrusted with the task. These organizations have a number of departments with specific duties. In France, for instance, there is a Bureau of Hydrology and Flood Warnings functioning for each of the river basins. These organizations are supervised by a Committee constituted by the Ministries of Public works, Interior, Agriculture and Commerce. There are also relevant organizations entrusted with researches regarding behaviour of rivers, characteristics of glaciers and lakes and utilization of water power. Hydrological data collected, analysed and interpreted by these expert organizations are taken advantage of in planning big projects. In the United States the National Resources Committee brings out publications on activities in connection with rain, river and snow gauging, forecasting of storms and floods, collection of stream flow and sub-soil water data, evaporation and transpiration losses and stream-behaviour studied by different organizations concerned with hydrology. In Russia, special emphasis is being given to hydro-physics, hydro-chemistry, hydro-biology, hydro-dynamics, hydro-meteorology, limnology, etc., and the data from these institutes are collated and standardized by suitable organizations.

We, in India, should like to be as systematic as any of the countries mentioned above. Our rivers carry much larger volume of water than those in Europe and U. S. A., their behaviour is more complex in that there has been age-long interferences and tamperings with them. The river valleys in India are again much more densely populated than those in other countries. So any scheme of river training in our land is likely to affect millions of people and we have no room for adventurism or complacency. We must build on solid data for which we look to the Geophysical Committee for proper deliberation and suitable action.

RECENT ADVANCES IN THE CHEMISTRY OF ANTIMALARIALS

H. L. BAMI, B. H. IYER and P. C. GUHA,
BANGALORE

MALARIA is one of the major medical problems of the world. India being the most malarious of all countries, suffers the most, especially due to lack of proper drug treatment. The time honoured treatment for this malady has been the cinchona alkaloids. Quinine, the most important of these alkaloids has been the official remedy for a long time. But the limited and localized production of quinine coupled with its non-availability during times of stress, stimulated efforts to discover synthetic antimalarials. The elucidation of the structure of quinine greatly helped the researches in this direction. In the present article a brief review of the recent advances in the chemistry of synthetic antimalarials during the years from 1938 through 1946 has been made. This period has been chosen with a view to studying the concentrated efforts made during a period of extreme stress due to war conditions.

Early efforts which were confined to the synthesis of quinine type of compounds were followed later on by different kinds of changes(1) effected in the quinine molecule itself and most of such compounds were found to be ineffective or inferior to quinine in their activities.

Quinine, Plasmoquin and Atebrin are not considered as perfect antimalarials because none of these can sterilize the blood or prove as a causal prophylactic. Their action is selective and in the case of plasmoquin, its toxicity is a handicap. Hence the search for a perfect antimalarial still continues.

During the World War II, American chemists prepared and tested more than 14,000 compounds comprising 70 structurally different types. This study enabled them to narrow down the field of search to 4 or 5 chemical groups, *viz.*, 4- and 8-amino-quinolines, quinolyl-4α-piperidylemethanols, quinolyl-4-dialkylaminomethanols and certain 1 : 4-naphthaquinones(2). The development of a quick test called "Screening Test" for antimalarial activity of a compound by which even a slight prophylactic activity would not be missed undetected, facilitated the testing of the large number of compounds in a short time(3).

In England, Curd and Rose opened a new line of research in the field of pyrimidines which led to the discovery of Paludrine as an antimalarial(4). In the field of sulphanilamides, sulphadiazine and metachloridine are important drugs for the treatment of malaria.

In spite of much data nothing definite has yet been formulated connecting chemical structure to chemotherapy. The mode of action of these drugs is also yet not fully clear. Most of the drugs act as inhibitors for respiratory catalysts(5,6). The modern approach to the chemotherapy of malaria is from the point of view of antagonism of essential respiratory factors like riboflavin(7). This view is gaining attention but it is too early to vouch its validity. Only active co-operation of chemists, pharmacologists and medical men will help to evolve the ideal antimalarial drug. Discovery of paludrine, chloroquin and metachloridin as well as a better understanding of the action of quinine, atebrin and plasmoquin has brought us sufficiently near the goal ; but there remains much to be done.

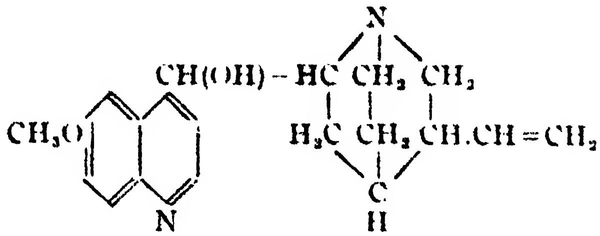
In this review, the various compounds falling under the category of antimalarials, have been classified under the following headings : 1 Alkaloids, 2. Quinoline derivatives, 3. Acridine derivatives, 4. Sulphonamides, 5. Pyrimidine derivatives, 6. Amidines, guanides and biguanides, 7. Phenanthrene derivatives, 8. Organometallics and 9. Miscellaneous.

1. ALKALOIDS

Of the thirty alkaloids identified as constituents of cinchona bark, quinine, quinidine, cinchonine and cinchonidine are in descending order of usefulness in the treatment of malaria(8, 9), quinine being the most potent and the least toxic. This drug has no action on sporozoites but acts as suppressive by removing the asexual forms of malaria parasite from the peripheral blood. It has little or no action on gametocytes and its action is limited to the period of administration. Totaquin (Cinchona febrifuge) which is a mixture of cinchona alkaloids, was found to give results less encouraging than quinine(10, 11).

Various other alkaloids have also been tested as possible antimalarials. Contrary to popular belief, the total alkaloids from *Alstonia sholaris* were found to be inactive(12). "Sinine"—a crystalline alkaloid from the roots of an ash tree was found to resemble quinine in its action(13). Opium alkaloids proved useless in this field(14). The extract of roots of *Dichroa febrifuga Lour* was less useful for tertian malaria than for bird malaria(15). Prochinin(16) (47·5% cinchonidine, 47·5% cinchonine and 5% quinidine) was a suitable substitute being one and a half times as active as quinine. Metabolic products of quinine were supressive in the case of avian malaria and have the same chemotherapeutic index as quinine(17).

Although total synthesis of quinine (I) has been achieved[18], it would be a long run before synthetic quinine can be made available for therapeutic purposes.



(I)

Saturation of the double bond in quinine molecule has been recently found by Marshall(9) to double its activity(9). It has also been found that an optically active selective chemoceptor(19) is not responsible for antipalasmodial activity. Comparison of quinine alkaloids with their hydroderivatives for bird malaria has shown that the latter are more effective although slightly more toxic(20). Similarly, quinine derivative of hydroxyethylapocupreine was found equal in activity to quinine hydrochloride and much less toxic in bird maralia(21).

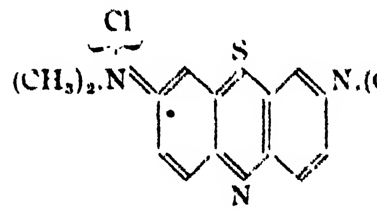
Changes in the central · CHOH – bond of quinine molecule almost invariably lowered the activity(22). Ainley and King(23) prepared synthetic analogues of quinine and cinchonine of the type 4-(6-methoxyquinolyl)- -piperidylcarbinols and found some of them to be active. Nandi(24) prepared the isomeric analogues of dihydrocinchonine and dihydroquinine, both of which were inactive. Prelog *et al*(25) synthesized vinyl free cinchona alkaloids and observed that vinyl or ethyl group in position 3 of quinine molecule is not essential for antimalarial activity. Rabe *et al*(26) have however contradicted this observation. Vinyl free quinines were synthesized in all the four possible optical isomers and tested(27, 28, 29).

α-Piperydyl -6- methoxy -4- quinolylcarbinol(30) (Niquidine with the side-chain removed) was synthesized and found to be less active than quinine. Similar derivatives were also studied by King and Work(31). Niquidine(32), an active degradation product of quinine, and allied derivatives were prepared by Work(33) and found to be as active as quinine.

Quinine and β-isoquinine were converted by ozonization into quininol and 3-hydroxyethyl-6′-methoxyrubinol respectively and reduced subsequently to the corresponding carbinols(34). Though active, none of these compounds showed antiplasmodial action equal to that of quinine when tested on *P. relictum* in canaries(24).

2. Quinoline derivatives

The elucidation of the structure of quinine stimulated interest in the field of quinoline derivatives as antimalarials. Following the observation of Ehrlich that methylene blue (II) has some inhibitory action on malarial parasites, Schulemann *et al*(35) discovered the first synthetic antimalarial of repute, namely, Plasmoquin (III), being 8-(4-diethylamino-1-methylbutylamino)-6-methoxyquinoline. Plasmoquin is not a mere substitute for quinine but has unlike quinine or atebrin marked gametocidal action in the case of all the three types of human malaria. It reduces relapses when given in conjunction with atebrin or quinine and exerts considerable schizonticidal action in benign tertian and quartan malaria. But its chief disadvantage is the small margin that exists between the therapeutic and toxic doses.



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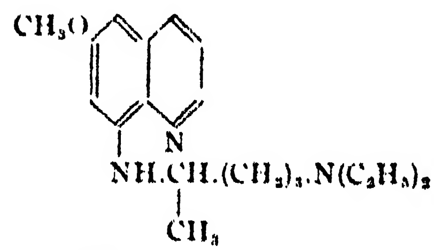

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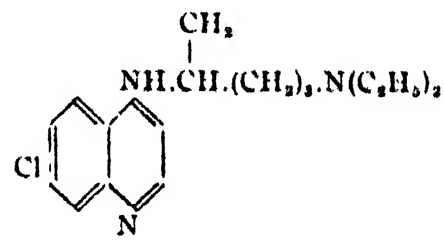


(IV)

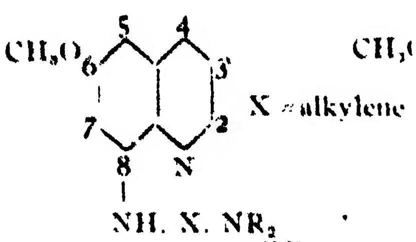
During World War II, American chemists prepared a very large number of quinoline and allied derivatives and have rediscovered a drug called 'Chloroquin'(2, 36), also known as SN. 7618, Reschin or Arelen, (IV), being 7-chloro-4-(4′-diethylamino-1′-methylbutylamino)-quinoline. This was first reported by Germans but was abandoned as it was considered too toxic(2). This drug is a suppressive which acts like atebrin but is much better tolerated. Santochin was a German product being 3-methyl-4-(4′-diethylamino-1′-methylbutylamino)-7-chloroquinoline (SN. 6911) which does not prove to be as good as chloroquin.

Certuna(37) which is 6-hydroxy-8-(4′-diethlamino-butyl-2′-amino)-quinoline combined with methylene-bis-2-hydroxynaphthionic acid and quinine was used to check malarial infections. Cilional(38), an anti-

malarial of plasmo ... d as effective as and less toxic than plasmoquin. Paludex(29), (double salt of sodium and copper of hydroxyquinolinedisulphonic acid and quinine salt) was found to be useful only due to its quinine content.

Researches in the field of quinolines have been divided in the following sub-headings: (a) 8-aminoquinoline derivatives, (b) 4-aminoquinoline derivatives, (c) 4-quinolylmethanol derivatives, and (d) benzoquinoline, pyrido quinoline and other derivatives.

Various compounds having the general structure 6-methoxy-8-(dialkylaminoalkylamino)-quinoline (V) (40-58) with variation in the side-chain and its replacement by heterocyclic amines have been prepared. Magidson and Pobysher(46) have shown that the therapeutic index is highest when the number of carbon atoms in the side-chain is four. According to Schonhofer(46) only amino quinolines substituted with a basic chain at 4-, 6- or 8- position have activity. Highest therapeutic index of 125 was obtained by him in the case of 5-, 6-dimethoxy-8-(5-diethylamino-2-pentylamino)-quinoline. Compounds of the type 5-phenylamino-6-methoxy-8-(8-diethylamino-propylamino)-quinoline(59), 2-methyl-5-methoxy-8-(dialkylaminoalkyl amino)-quinoline(51), 5-halogeno-8-(α-methyl-δ-diethylaminobutylamino) - quinoline(60), and 5-amino-8-(2-diethylaminoethylamino)-6:7-dimethoxyquinoline(61) have been prepared but no pharmacological results have been reported. Gilman and Beakeset(62) have prepared sulphur analogues of plasmoquin *i.e.*, 8-(3-diethylaminopropylamino)-6-quinolylmethyl sulphide, while simple dialkylamino polymethylene ethers of 8-hydroxy-6-methoxy quinoline were prepared and found inactive(63). Barbar and Wragg(64) prepared a tetrahydro plasmoquin and studied its action.



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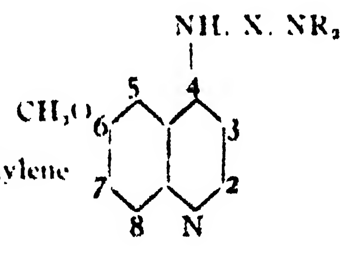

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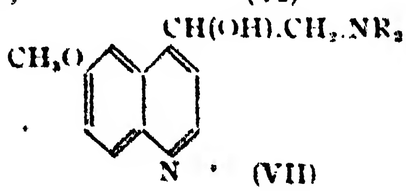
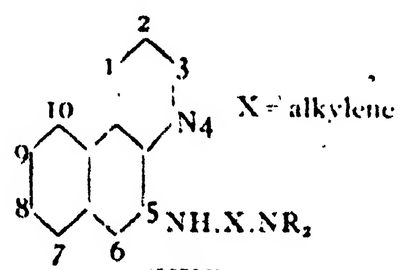


(VII)

In the case of 4-aminoquinoline derivatives, various compounds having the formula 4-dialkylaminoalkylamino-6-methoxy quinoline (VI) have been prepared and according to Halperin(65) this type of drugs are all schizonticides like quinine. Gilmann and Spatz(66) prepared quinoline derivatives as open models of atebrin of the type 6-methoxy-2-(3-chlorophenyl) - 4-(1-methyl - 4-diethylaminobutylamino)-quinoline. Compounds of the type 7-choloro-2 or 4-(dialkylaminoalkylamino)-36, 68, 70-74-quinoline and its 8-methyl analogues(75) have been prepared and reported active, while 6- and 7-chloro-4-(2 p-phenyl-substituted - 4-dialkylaminoalkylamino)-quinolines(71, 74), 3-iodo-5- or 7-chloro-4-(diethylamino-1-methyl-butylamino)-quinoline(76), 1-(dialkylaminoalkylamino) iso-quinolines(77), 2-(dialkylaminoalkylamino)-6:7-dimethoxyquinolines and 5:8-diacylamino-6:7-dimethoxy quinolines and other similar derivatives were prepared for testing their antimalarial activity.

Simplified compounds based on the quinine structure having the formula α-(2-piperidyl)-4-quinoline-methanol were first studied by Ainley and King(80). King and Work(81, 82) prepared various dialkyl-aminomethyl-6-methoxy-4-quinolylcarbinols (VII) and found them inactive in bird malaria. Turner *et al* (83) and Winstein *et al* (84) also studied α-(dialkyl-aminomethyl - 8-amino-2-phenyl-4-quinolinemethanols and their 8-hydroxy analogues. Buchmann *et al* (85) prepared α-chloroquinolyl-4-α-piperidylcarbinols and their 6, 8-dichloro derivatives while Sargent(86) prepared various 6-methoxyquinolyl-4-α-piperidylcarbinols 6-chloro - 2-phenylquinolyl - 4-α-piperidylcarbinols(87) and their N-methyl derivatives, 8-chloro analogues and 6- and 8-methyl or chloro analogues(88) were also prepared. 7-Chloro-α-(2-piperidyl)-4-quinolinemethanols(89), 2-alkyl-α-(2-piperidyl)-4-quinoline-methanols(90) and 2-phenyl-α-(2-piperidyl)-4-quinolyl-methanols(91, 92) have also been prepared.



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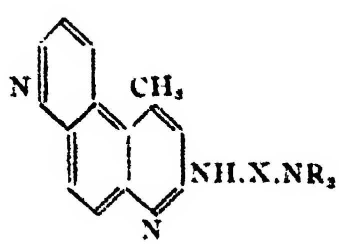

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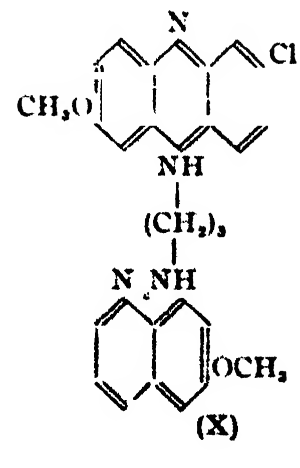
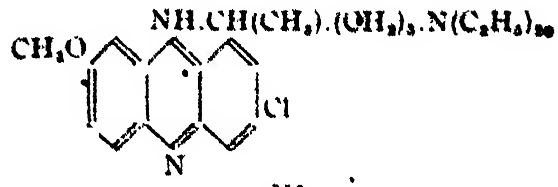


(X)

Various 8-(dialkylamino or heterocyclic aminoalkylamino)-6-methoxy benzoquinolines have been prepared and it is noted that the methoxy group is essential for activity(9). Compounds of the type, 5-(dialkylaminoalkylamino) - benzo - (f)-quinolines (VIII),(94), 1-p-hydroxyanilinomethyl-benzo-f-quinolines(95) and 4-dialkylaminoalkyl-amino)-7 : 8-benzoquinolines(96) have also been prepared but their pharmacological examination have not been done. Guha and Swaminathan(97) have prepared chloroalkoxy-and dialkylaminoalkylamino substituted 7 : 8-benzoquinolines. Price *et al*(98) reported 4-(4-diethylamino-1-methylbutylamino) - 7-chloroquinazoline having antimalarial activity equal to quinine and similar derivatives were also prepared by other workers(99, 100). Das Gupta and Ghosh(101) prepared 2-hydroxy-6-methylpyridino-(3′ : 4′)-2-hydroxyquinolinedisulphonic acid but no tests have been reported. 2 or 4-Dialkylaminoalkylamino-4 or 2-methyl 5 : 6-3′ : 2′-pyrido quinoline (IX),(102), as well as 2-dialkylaminoalkylamino - phenanthrolines(103, 104) have been prepared but no tests have been reported. Quin and Robinson(105, 106) combined atebrin and plasmoquin and prepared a compound having the formula 2-chloro-5-(6′-methoxyquinolyl-8′-aminopropylamino)-7-methoxyacridine (X). Some heterocyclic compounds from 6-methoxyquinoline-8-hydrazine have been prepared but found inactive(107).

3. Acridine Derivatives

The most important antimalarial of this series known so far as Atebrin (Mepacrin, Quinacrine, Proquin or Acrichine) being 2-methoxy-6-chloro-9-(4-diethylamino-1-methylbutylamino)-acridine dihydrochloride (XI) which was discovered by Mauss and Mietzch(108). Its chemotherapeutic action was first elaborated by Kikuth(109). Toxicity, absorption, excretion and parasiticidal action of this drug has been exhaustively studied by many workers(110-117). Atebrin at high dosage level is the most effective remedy for recurrent attacks of malaria and there are not many toxic effects(115). It imparts a yellow colour to the skin, which, though harmless, is not desirable ; it is absorbed rapidly and excreted slowly and unlike quinine, has a direct parasiticidal action(118). Atebrin is essentially a schizonticide with limited action on gametes in human malaria and its prophylactic nature is questionable(118). Butylacridine being 2-methoxy-6-chloro-9-(diethylaminobutylamino)-acridine (XIII),(6, 114, 119, 120), was also found effective in controlling malignant tertian and benign tertian malaria without the possibility of relapse in the latter case. Acriquin(121), another acridine derivative was also claimed to be as potent as atebrin.



(XI)

(XII)

Researches of major importance in the field of acridines have been directed towards compounds having various different substituted alkyl chains at 9-position of the atebrin molecule. Numerous derivatives of the type 6-chloro-2-methoxy-9-(dialkylaminoalkylamino)-acridine(105, 122-132) have been prepared. Compounds of the type 2-methoxy-4-nitro or alkylamino - 6-chloro-9-(diethylamino - α-methylbutylamino)-acridine have been prepared and found to be less active(133). 2-Methoxy-9-(dialkylaminoalkylamino)-acridines and 3-chloro-7-methoxy-9-(dialkylaminoalkylamino)-acridines showed considerable activity(130) while 3-chloro-5-methyl-9-(dialkylaminoalkylamino)-acridines were inactive(127), but 3 : 6-dichloro-9-(1-methyl-4-diethylaminobutyl amino)-acridine was found to be as active as quinine in avian malaria(134). Singh and Singh(135) prepared 2-methoxy-5-chloro-9-(dialkyl-aminoalkylamino) - acridines. Various 2 chloro-5-(dialkylaminoalkyl or aryl amino)-7-methoxy acridines(136), 1-chloro-9-methyl-5-(dialkylaminoalkyl or aryl amino)-acrimines(136), 3-chloro-7-methoxy - 9-(6′-methoxy-8-quinolylamino)-or 9-(6′-methoxytetrahydroquinolino)-acridines(137) and their 9-(dialkylaminoalkylamino) analogues(138) have been prepared and tested. Drozdox and Bekhli(139) prepared 2-dialkylamino-6-chloro-9-phenoxyacridines. Derivatives of the type 7-(ν, dialkylaminoalkylamino) - 2-methoxybenzo- (c) -acridines were found devoid of activity(140). 8-Chloro-5-dialkylaminoalkylamino - 3 : 4-2′ : 3′ - pyridoacridines and 8-chloro - 4-methoxy - 5-dialkylaminoalkylamino-1 : 2-2′ : 3′pyridoacridines were prepared and only the first series was found to be active(141). Various 1 : 1-dialkylamino-4-substituted benzylidenepentanes as anils of open models of atebrin were prepared but all were found inactive(142). Considering atebrin as a chlorobenzo derivative of 6-methoxy-4-(δ-diethylamino-α-methylbutylamino)-quinoline(143), a few 8-methyl- or 7 : 6-dimethyl-2-(p-substituted phenyl)-quinolines were prepared and 8-methyl-2-(p-dimethylaminophenyl)-quinoline showed some activity(144). 6-Chloro-2-methoxy-9-substituted acridines have been prepared where the substituents at the 9-position are

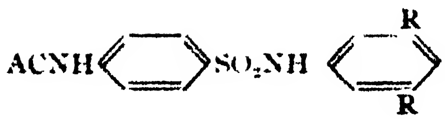
carbamide, thiocarbamide, semicarbazide, substituted phenyl carbamide and thiocarbamide radicals(122, 145).

4. Sulphonamides

Due to the wide range of activity of the sulpha drugs against various infection they have been tested for their antimalarial activity also and synthetic researches on these lines have been carried out with the hope to find better drugs. It may be said that the antimalarial activity of these drugs is due to their antibacterial property, both of which are inhibited by para-aminobenzoic acid. It will be of interest to mention that the effect of atebrin or quinine on plasmodia is not inhibited by p-aminobenzoic acid and hence their mechanism of action may be different from that of sulphas(146).

Prontosil(147-149) and "prontosil soluble"(150) showed varying amount of activity in avian malaria in heavy doses but showed no advantage over other drugs. Sulphanilamide proved quite effective against simian malaria and its salts with cinchona alkaloids were active only in proportion to their quinine content(151, 152). Sulphanilamide(151, 153-156) was further pharmacologically studied and reported to be prophylactic and curative for bird malaria(157). Various other sulphas studied are sulphathiazole(151, 157), sulphapyridine(151, 154, 155, 157), sulphadiazine(151, 154, 158-64), sodium sulphapyridine(151, 155, 165), N^1-methylsulphathiazole(150, 166, 167), sulphamethylthiazole(154, 167), sulphamethazine(154), 2-sulphanilamido-5-*iso*-propylthiazole(167, 168), sulphapyrazine (161, 162), sulphaguanidine(169, 170), 5-sulphanilamidoquinoline(38, 40, 154), sulphanilamidobenzamide(154), N^1-(6-quinoxalyl)-sulphanilamide (154), 2-N^1-sulphanilamido-5-ethylthiazole(165), and 2-sulphaquinoxaline(161). Although most of these drugs have given encouraging results in simian and avian malaria, sulphadiazine seems to be the best and most effective for human malaria. In avian malaria, while Coggeshall(163) found that sulphadiazine prevented the appearance of exoerythrocytic forms and effected a cure, Walker and Van Dyke(159) and Brackett *et al*(160) considered it less effective than quinine or atebrin According to Thompson(152) sulphadiazine is only a suppressive. Metachloridine (XIII) (SN. 11437) is another recent sulphaantimalarial having the formula 2-metanilido-5-chloropyrimidine. This drug although less active against benign tertian and malignant tertian malaria, is very useful for quartan malaria and is perhaps less toxic.

(XIII)



(XIV) R = Halogen

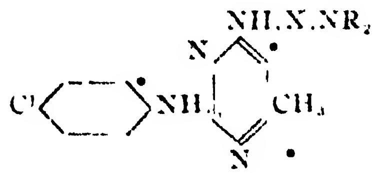
Work(171) prepared N^1-(6-methoxylepidyl)-sulphanilamide which though active was very toxic. Compounds of the type N^4-acetyl-N^1-(1 : 2 : 3 : 4 : tetrahydro-1-quinolyl)-sulphanilamide and N^1-acetyl-N^1-(6-methoxy - 8-quinolineamino) - sulphanilamide were prepared and only the latter type showed slight activity(172). Lydia and Aldo(173) prepared various possible antimalarials by coupling diazotised sulphanilamide, N^1-dimethyl- and N^1-diethyl-sulphanilamide with 8- and 6-hydroxy- and 6-aminoquinolines. Various sulphanilamido substituted acridines and acridylaminobenzenesulphonamides have been prepared(174-176) and some of them have been reported to be active(157). Halogenated sulphanilamido heterocyclics derived from pyrimidine ring, *e.g.*, 2-sulphanilamido-5-chloropyrimidine were also found to be active and not much affected by the presence of p-aminobenzoic acid(177).

N^1-Chloroacetyl- and N^1-caproyl derivatives of sulphadiazine, sulphapyridine and sulphathiazole were also prepared and the chloroacetyl derivatives were found to be less active than the parent drugs while the caproyl derivatives were as active(178). N^1-Acetylaminobenzenesulphonanilides (XIV) substituted at 3'-and 5' positions of the anilide nucleus by halogen or haloalkyl radical were prepared(179-181). Several dialkylaminoalkyl derivatives of sulphanilamide(182), 3'-bromo-4'-alkyl-sulphanilanilide, 3'-chloro-4'-diethylsulphanilanilide, substituted naphthyl sulphanilanilide and (5-chloro-4 : 6-dimethyl-2-pyrimidyl) sulphanilamide were also prepared but they do not seem to have been tested(183). Compounds of the type 5-amino - 8-acetyl-sulphanilamido-6 : 7-dimethoxy-quinoline have also been reported(61).

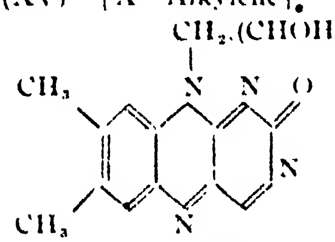
5. Pyrimidine Derivatives

Curd and Rose(184) postulated that compounds possessing pyrimidine ring system which is of biological importance would prove less toxic and more effective on account of the possibility of their longer retention in and greater tolerance by the body than compounds possessing quinoline or acridine nuclei which are systems foreign to human body. The marked activity of sulphadiazine, a prominent member of the sulpha group which has attained clinical importance, is a point in support of this postulate. Pyrimidine nucleus has the added advantage of being easy to synthesize and of being non-chromophoric in character.

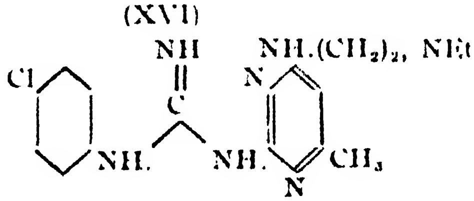
Firstly, Curd and Rose(184, 185) prepared 2-arylamino-4-dialkylamino-alkylamino-6-methyl pyrimidines (XV), all of which proved inactive in avian malaria. Further variations in the above mentioned type of pyrimidines led to more fruitful results(186, 187). However, it was observed that the presence of the chlorine atom in para position in the aryl group was essential for antimalarial activity which was inhibited by riboflavin (XVI), an essential metabolite for parasites. Various 4-dialkylaminoalkylamino methyl substituted pyrimidines were then prepared and tested by Hull *et al*(188) and a number of them showed marked activity. The drugs were supposed to be riboflavin antagonizers and to act by interference with nucleoside synthesis.



(XV) [X Alkylene]



(XVI)

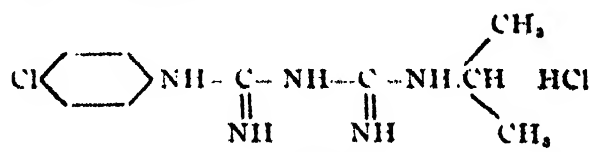


(XVII)

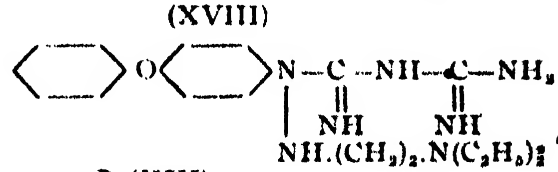
On the lines of work already done, Curd and Rose(189) prepared various 2-substituted phenylguanidino-4-dialkylaminoalkylamino-6-methyl pyrimidines several of which were active. The best of the series was 2-p-chlorophenylguanidino-4-diethylaminoethylamino-6-methylpyrimidine (M. 3349) (XVII) which was pharmacologically studied by Adams and Sanderson(190) and found to compare well with atebrin. This compound was also a riboflavin antagonizer. Various 2-substituted naphthylamino-4-dialkylaminoalkylamino-6-methylpyrimidines also possess good activity(191). The isomeric 4-aryl amino-2-dialkylaminoalkylamino-6-methylpyrimidine derivatives where the position of the substituents are reversed to those detailed before(184, 186) were active in avian malaria(192). These compounds were also structurally related to riboflavin and it was suggested that apart from Schonhofer's condition for activity(193), a compound must be structurally similar to riboflavin in order to be active. Various 4-arylamino-6-dialkylaminoalkylamino-2-methyl pyrimidines have also been prepared(194, 195), and some of these compounds were found as effective as atebrin in avian malaria. All these compounds seem to fulfil Schonhofer's theory of quinoid tautomeric forms, an essential condition for activity.

6. Amilines, Guanides and Biguanides

The most important drug in this series is Paludrine (XVIII) being N^1-p-chlorophenyl-N^5-isopropyl-biguanide hydrochloride or acetate which in relatively small doses has a complete and permanent effect in preventing *P. falciparum parasites* gaining access to the blood stream. It thus serves as a true causal prophylactic and has a sterilizing action on the presumed exo-erythrocytic forms of malaria parasites(196, 197). In the case of *P. vivax* infection it acts only as an inhibitory drug and has no lethal action on exo-erythrocytic forms. Relapses occur although less frequently than in the case of atebrin therapy(195, 198). It has no action on sporozoites and does not stop appearance of gametocytes in *P. vivax* and *P. falciparum* infections. It can serve as a single dose cure and is relatively less toxic and absolutely non-staining in character.



(XVIII)



(XIX)

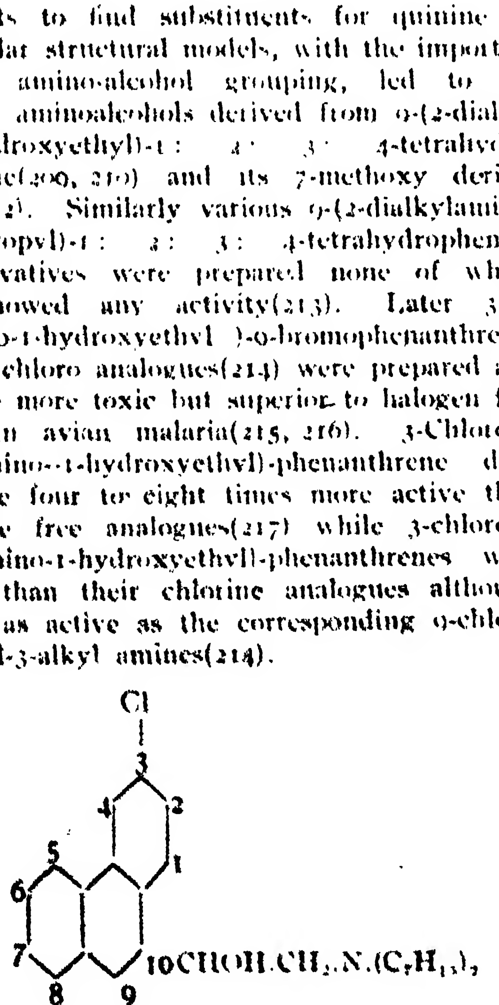
In pyrimidines antimalarial activity might be expected when aryl amino and alkylamino substituents are present in the molecule(199), and permit the formation of ortho- or para-quinoid tautomers. Various tautomeric considerations led to the idea that a ring system is not necessary and any hetero-enoid system like $HN-C\langle{}^{\textstyle N}_{\textstyle N=C-NH}$ might function in the same way. With this idea Curd and Rose(200) prepared a number of derivatives of the type N^1-p-chlorophenyl-N^5-dialkylaminoalkylbiguanide but found them inactive due to their being too basic in nature and possibly due to the influence of the alkyl chain on the tautomeric character of the compounds. The dialkylaminoalkyl chain was simplified and various simple alkyl radicals were substituted. N^1-p-chlorophenyl-N^5-methylisopropyl-biguanide (M. 4430) and N^1-p-chlorophenyl-N^5-isopropyl-

biguanide (M. 4388) were ultimately discovered(199). M. 4430 also gave encouraging results in benign and malignant tertian malaria(197, 200), but was less potent than paludrine(206). Replacement of the alkyl radical by an aryl in paludrine structure led to less active drug(199).

It may be mentioned in this connection that the first antiplasmodial drug of this type was mentioned in a German Patent(201) having the structure (XIX). King and Tonkin(202) prepared and examined a large number of substituted aryl guanidines and biguanides following the finding that p-tolylguanidine nitrate was slightly active in retarding the sporozoite induced infection of P. galinaceum and p-anisylguanidine nitrate was discovered to have better activity although it did not cure the disease. Some alkyl substituted guanidines showed definite causal prophylaxis(202). Various N^1-phenyl substituted-N^5-p-sulphonamidophenyl biguanides have also been prepared(207). Yorke(203) prepared a number of diamidines out of which 4'4'-stilbenediamidine(204, 205, 78) was most effective.

7. Phenanthrene Derivatives

Attempts to find substituents for quinine by having similar structural models, with the important feature of amino-alcohol grouping, led to the synthesis of aminoalcohols derived from 9-(2-dialkylamino-1-hydroxyethyl)-1 : 2 : 3 : 4-tetrahydrophenanthrene(209, 210) and its 7-methoxy derivatives(211, 212). Similarly various 9-(2-dialkylamino-1-hydroxypropyl)-1 : 2 : 3 : 4-tetrahydrophenanthrene derivatives were prepared none of which however showed any activity(213). Later 3-(2-dialkylamino-1-hydroxyethyl)-9-bromophenanthrenes and their 9-chloro analogues(214) were prepared and found to be more toxic but superior to halogen free analogues in avian malaria(215, 216). 3-Chloro-6-(2-dialkylamino--1-hydroxyethyl)-phenanthrene derivatives were four to eight times more active than the chlorine free analogues(217) while 3-chloro-9-(2-dialkylamino-1-hydroxyethyl)-phenanthrenes were not better than their chlorine analogues although four times as active as the corresponding 9-chlorophenanthryl-3-alkyl amines(214).



(XX)

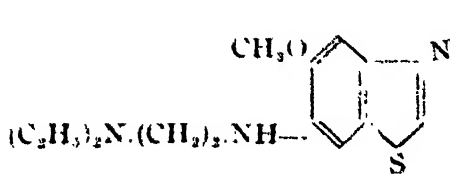
In this series 3-chloro-10-(2-diheptylamino-1-hydroxyethyl)-phenanthrene (SN. 1375) (XX) was tested clinically and found to be superior to quinine for *P. vivax* infections(217). 3-Bromo- and 2 : 3- or 3 : 4-dichloro analogues of SN. 1375 were found to be as good(218, 219). In order to test the hypothesis that for antimalarial activity secondary carbinol group of alkylamine chain should be directly attached to an aromatic or heterocyclic ring with aromatic character, various 9-(dialkylamino-2-hydroxypropyl)-phenanthrenes and 1 : 2 : 3 : 4-tetrahydrophenanthrene derivatives were prepared but were found to be more toxic and less active than their lower homologues(220). All these derivatives were ineffective against sporozoite induced infections.

8. Organo Metallics

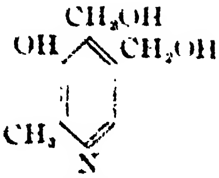
Following the introduction of malaria therapy in syphilis of central nervous system, the arsenicals were tested as antimalarials. Mapharsen and neoarsphenamine were used to control simian malaria but the infection was incompletely controlled(221). Winckel(222) used the latter drug for induced malaria infection of paretics and found it having more marked action on *P. vivax* than on *P. malariae* or *P. falciparum*. Ghosh and Roy(223) have prepared p-(8-ethoxy-5-quinolylsulphonamido)-benzenearsonic acid type of derivatives with a view to studying their antimalarial property. Sodium iodobismuthite was tested for avian malaria and its action was more intense against young merozoitic forms than that of quinine(224). Various 2-hydroxy-4-methylquinoline-6-arsonic acid and 2-phenyl-8-hydroxy quinoline-5-arsonic acid have also been reported by Banerjee and Ghosh(225). M_1(255) which is a preparation composed of $MgHg_2I_2$ and spleen extract, also failed to come up to the expectations as an antimalarial.

9. Miscellaneous

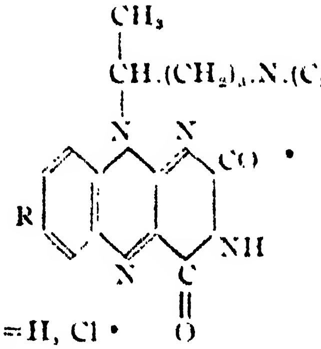
In spite of their resemblance to simiar quinoline and acridine compounds, 6-methoxy-7-(β-diethylaminoethylamino)-benzothiazole (XXI),(226) 4-(β-diethylaminoethylamino) - 6-methoxy - benzothiazole derivatives(226), and 2-(δ-diethylamino- methylbutylamino)-6-chloro or iodo- substituted benzothiazoles(227) showed no antimalarial activity. Guha and Guha(145) also prepared some 6-methoxy-2-phenylcarbamido-benzothiazoles. Considering that pyridoxin (XXII) might be an essential metabolite for malaria parasite(228), 4-dialkylaminoalkyl-2-methyl-3-pyridol type of compounds have been prepared but no pharmacological tests have been reported(229-230).



(XXI)



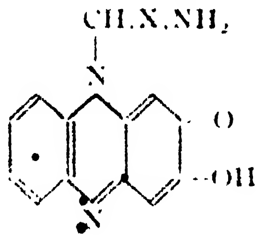
(XXII)



R = H, Cl

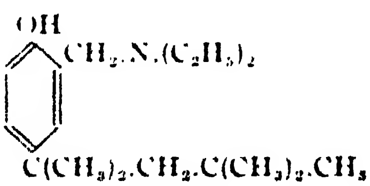
(XXIII)

Various dialkylaminoalkyl-1-napthylmethanols (231, 232) and their 4-substituted derivatives(233) have been prepared but not tested pharmacologically. Neemann(234) has replaced acridine nucleus of atebrin by isoallxazine derivatives (XXIII) in order to have a drug of better activity, in view of its closer resemblance to riboflavin. King and Acheson(235) and Hall and Turner(236) have also prepared similar derivatives. 2-Keto-3-hydroxy-6-substituted-9-dialkylamino-α-alkylphenzines (XXIV) which showed slight activity were prepared by Jones(237).



(XXIV)

X = alkylene



(XXV)

1-(Dialkylaminoalkylamino)-3-chloro or methoxyphenazines(238) and p-dialkylaminoalkylaminophenothiazines(239) showed only slight antimalarial activity.

By synthesizing N-2-(diethylaminoethyl)-anilines and N : N′-bis-(2-diethylaminoethyl)-substituted anilines, Stahmann(240), showed that replacement of quinoline or acridine by phenyl nucleus made the compounds inactive. Similarly, to establish the activity of α-diethylamino-4-(1 : 1 : 3 : 3-tetramethylbutyl)-ortho-cresol (XXV) in avian malaria, as many as 128 compounds of similar structure were prepared and tested and were found to be one to four times as active as quinine(241). Some derivatives of 3-amino-4-(dialkylaminoalkylamino)-chlorobenzene have also been prepared as possible antimalarials but they were only slightly active(242). Glutaconaldehyde derivatives of the type N-[5-(6-methoxy-8-quinolylamino)-2 : 4-pentadienylidene]-2 : 4-dinitroaniline have been prepared and found active(243). Various 3-dialkylaminoalkylamino-6-iododibenzofuran and compounds of similar types have also been found to possess slight activity(244). A few dialkylaminoalkyl-p-phenyl substituted methanols and substituted borneols have also been reported(245, 246). Several butyolactones(250), substituted carbolines(251), and 4-dialkylaminoalkylamino-2-methyl-5 : 6-2′ : 3′-pyridoquinolines(247), have been prepared.

2-Dialkylaminoalkylamino-pyridine and thiazole (252), 4-benzamido-3-(3-diethylaminopropylamino)-anisole and 3-diethylaminopropyl-benzimidazole(248, 249) were all found to be inactive. Thiobismal(253, 256, 258) was found partially effective in human malaria while Tyrothricin(254) is effective in avian malaria. Streptomycin(257) has however no suppressive action in avian malaria. 4-(Dialkylamino-alkylamino)-6-methoxyquinazolines have also been reported(259, 2260).

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Notes and News

ARTIFICIAL PRECIPITATION

E. B. KRAUS and P. Squires, of the Division of Radiophysics, Council for Scientific and Industrial Research, Commonwealth of Australia, have reported in *Nature*, April 12, 1947, the results of a series of experiments on the artificial stimulation of rain, recently carried out in Australia, under the auspices of the Council. These experiments were based on a theory due to Bergeron, developed in 1933, that precipitation occurs from clouds containing both water drops and ice-crystals. The natural cumulus clouds often contain supercooled water drops, but no ice crystals. On Bergeron's theory, precipitation may be induced from such clouds by artificially injecting ice crystals into the clouds.

In the United States, Langmuir and Schaeffer already succeeded in inducing precipitation of snow by dropping pellets of solid carbon dioxide into the supercooled clouds from aircraft. The Australian experiments, now reported, also followed the same technique but appear to have been carried out on a much wider scale.

Of the eight different clouds treated, rain was formed on six occasions, and heavy precipitation was actually observed on the ground on four occasions. In one of these experiments, 100 lbs. of granulated carbon dioxide were dropped from air into a cloud, and a few minutes after, 150 lbs. of dry ice were dropped into a second cloud. In less than five minutes, write the authors, rain echoes from within the clouds were recorded on the aircraft's 10 cm. radar equipment. Shortly after, another contingent of 150 lbs was dropped into the clouds, when the echoes grew in intensity. Within twenty-one minutes after the cloud was first infected with pellets of dry ice, it was raining heavily, covering an area of about 20 square miles. No other rain was observed within hundred miles of the aircraft.

The whole progress of the experiment was also recorded in a 25 cm. radar set operated from George's Heights in Sydney. Rain echoes appeared on the radar screen in the area of the first drop after 18 minutes of the injection of dry ice. In the case of the second cloud, such echoes were received after 16 minutes.

Another peculiarity observed in course of these experiments was the remarkable rise of the infected cloud in the shape of a narrow towering anvil, which reached a height of about 40,000 feet. This is believed to be due to sudden liberation of heat or fusion during the process of transformation from vapour to ice.

The authors state that these experiments were carried out under favourable meteorological conditions. The minimum meteorological conditions necessary for inducing such artificial precipitation are, however, still unknown, and as such the future possibilities of practical application of this method are dependent on further experiments and collection of meteorological data in this direction.

GIANT SUNSPOTS

THE months of March and April of this year have been characterized by intense solar activity and appearance of giant sunspots, some of which are now reported to have surpassed in size any observed to date. The sunspot group which crossed the sun's disc between March 3 and 17 at lat. 22° south had a maximum area of about 4,300 millionths of the sun's visible hemisphere and is one of the largest groups on record. The March group was followed by another of exceptionally large size, which crossed the sun's disc between March 31 and April 13 in the lat. 24° south. According to a report in *Nature*, based on information supplied by the Royal Observatory, Greenwich, the first group observed early in March returned in April, but had either grown meanwhile or had experienced new formation. The latest spot had a peak area of about 5,400 millionths of the sun's hemisphere and, from the view point of size, is the largest in the Greenwich photographic record being maintained since 1874-75. The following list records sun spots exceeding 3,000 millionths of the sun's hemisphere :

Year	Central meridian passage	Maximum area	Magnetic storm: Great or small	Magnetic storm: Begins
1947	April ... 6·8	5400	None	—
1946	Feb. ... 5·5	4900	G	Feb. ... 7·4*
1947	March ... 10·2	4300	s	March ... 8·3
1946	July ... 26·8	3950	G	July ... 26·8*
1926	Jan. ... 24·5	3716	G	Jan. ... 26·7*
1938	Jan. ... 18·4	3627	G	Jan. ... 22·2*
1937	Oct. ... 4·5	3340	s	Oct. ... 3·5
1938	Oct. ... 11·9	3003	(s	Oct. ... 7·4)

An asterisk denotes that an exceptionally intense solar flare was observed in $H\alpha$(6563A.) at one or more observatories at the following respective time-inter-

vals preceding the beginning of the storm: 18, 26½, 24 and 29 hours.

It is of interest to note that four of the largest sun spots have been observed in course of the last fourteen months, which coincides remarkably with the well known eleven-year solar cycle.

During the occurrence of the first group of sunspots in March 3 and 17, two geomagnetic storms of not very great intensity were reported. But what was very striking was the absence of any great magnetic storm generally associated with such big sunspots. Another important feature of the recent solar activity, as indicated by radio fade-out data, was that the sunspots were not associated with solar flares and like chromospheric activity such as occurred in the past during such activity. According to these radio data of fade-outs on short-wave long-distance transmission, no intense solar flare occurred over the spot when it was more nearly in line with the earth. Giant sunspots of the past, as indicated in the table, were generally associated with such flares which resulted in complete and prolonged fade-outs often lasting for an hour or more in day-light circuits. So far as is known to us, no convincing explanation of such inconsistencies, at present seriously engaging the attention of astrophysicists, has been suggested.

IRRIGATION AND RIVER DEVELOPMENT IN INDIA

The Central Board of Irrigation have just issued a series of popular leaflets dealing with various aspects of multi-purpose development of rivers in India. The three leaflets, under review have considered the following subjects, *e.g.*, irrigation in India (leaflet No. 1), irrigation research in India (leaflet No. 2), and new projects for irrigation and power, (leaflet No. 3, 1047).

The leaflet No. 1 presents a brief historical review of irrigation developments since the beginning of the present century and during the two world wars, in particular, and has focussed attention on such questions as the loan work, the Irrigation Commission, the finance and the revenue.

Development of research in irrigation is of comparatively recent origin; but the workers in this field have undoubtedly given a good account of themselves. The leaflet No. 2 records that the hydrodynamic research stations in India made considerable progress in the design of earthen irrigation channels which made possible the great developments that have since taken place in irrigation works. Another notable achievement has been the design of hydraulic structures on sandy or permeable foundations for which the Indian workers were the first to have given the final theory. Other important contributions of these research stations relate to design of canal structures of all kinds, devices for the exclusion of silt, methods of dealing with scour caused by falling waters, and devices for automatic and equitable distribution of water.

The leaflet No. 3 presents in a nut-shell the new irrigation and hydro-electric power projects, under construction or investigation in the current year. In Bengal, the three important projects now under investigation is the Damodar Valley, the Mor, and the Tista Projects. We have recently reported extensively on the former two projects and understand that work on the Mor Project has already been started. The Tista Project comprises a dam across the Tista, just up-stream of the Coronation Bridge, which will be about 700 feet high and will impound 3·5 million acre feet of water. The installed capacity of the power plant will be over half million KW. The most important multi-purpose river development scheme in Bihar, apart from the Damodar Valley Project, is the Kosi Valley Project which alone would provide for a storage of about 10 million acre-feet of water and continuous hydro-electric power of about one million KW. In Bombay, the following projects are now under investigation: The Girha Storage, the Gangapur Storage, the Mula Storage, the Vir Dam, the Mahi Canal, and the Tapti Canal. The total storage capacity of all these projects when completed will amount to about 1·5 million acre feet and extensive irrigation facilities are envisaged. In Madras, the construction work in connection with the Tungabhadra Project has already been started. Among the other schemes, now under consideration, the Ramapadasagar Project on the Godavari contemplates the construction of a mile and a half long and 150 feet high masonry dam, with 200 feet of foundation below the river bed. The dam with a storage capacity of 12 million acre feet of water will be one of the largest in the world and will generate 75,000 KW continuously. A reservoir at Gondikota across the Pennar and the Lower Bhawani Project on a tributary of the Cauvery are two other projects in the province. In Orissa, work in connection with the Mahanadi Valley Project is now in progress. This year the Punjab will be busily engaged in the development of her many rivers and canals, and five projects are under consideration, *e.g.*, the Bhakra Dam Project, the Nangal Power Projects, the Thal Canal, the Rasul Hydel and Tubewell Project and the Mianwali Hydel and Pumping Project. The Bhakra dam alone will impound 3·5 million acre feet, and all these projects, in full operation, will generate continuous power of about 300,000 KW and provide irrigation over nearly 6 million acres of thirsty land. No less than six projects are also now being worked in U. P. The Sarda Hydro-electric Project has been put into operation and is expected to be completed by 1948. The other projects are the Nayar Dam Scheme, the Rihand

Hydel Project, the Ramaganga Dam Project, the Lalitpur Reservoir and the Nagwa Dam.

A number of irrigation and hydro-electric projects have also been implemented in the States. The Zankhari and the Sabarmati Irrigation Projects in Baroda, the Chalakudy River Diversion Work, the Naduthodu Irrigation Project and the Pillathodu Reservoir Scheme of Cochin, the Jawai Irrigation and Hydro-electric Project of Jodhpur, the Bhdra and the Kabini Schemes of Mysore, and the Chambul Hydro-electric scheme of the Rajputana States deserve special mention.

All these works coming into full operation, are expected to add 25 million acres of irrigation to India's existing 70 millions and about 4 million KW of hydro-electric energy to the existing power of half a million kilowatt.

INTERNATIONAL COMMITTEE OF WEIGHTS AND MEASURES

THE first preliminary session after the war of the International Committee of Weights and Measures took place during the last week of October 1946 in Paris. Many important decisions were taken during this session regarding standard specification for weights and measures.

The most important business arose out of the recommendations of the Advisory Committees appointed previously. The Advisory Committee on Photometry recommended that a new unit of candle-power based on the luminous intensity of a black-body radiator at the temperature of solidification of melted platinum (60 units per $Cm.^2$), should be substituted for the present international candle. Similarly, the Advisory Committee for electricity recommended substitution of the present international electrical units, as based on mercury ohm and the silver voltameter, by the absolute electrical units as based on the M.K.S. or the C.G.S. system. The Committee was unanimous on the adoption of the proposed new unit of candle-power which had already been adopted in Germany. With regard to changes in the electrical units, objection was, however, raised by the Physikalisch-Technische Reichsanstalt ; but this recommendation was also adopted by a majority decision.

The Committee discussed the Report of the Commission des Travaux on the work of the Bureau International des Poids et Mesures during the past seven years. Despite enormous difficulties due to war time conditions, the Bureau added new sections for the comparison of electrical photometric standards to deal with additional duties entrusted to it. Improvement has been effected in the accuracy of comparison of the metre standards, and the accuracy of comparison of two metre standards is now stated to be within 0·1 micron. The Committee has approved a proposal that the Bureau should undertake a new determination of the value of g by direct kinematic observation of a freely falling body.

Members of the Committee visited the vault at the Bureau, where the International Prototype Metre and the International Prototype Kilogramme are preserved. The members noted with satisfaction that none of the invaluable standards suffered from the enemy bombardment, although several bombs fell on the grounds of the Bureau.

Mr J. E. Sears (Great Britain) was elected president for the current session and M. Dehalu (Belgium) was elected secretary. The following were elected Presidents of Advisory Committees: Mr J. E. Sears—Advisory Committee for Electricity ; Mr E. C. Crittenden (U. S. A.)—Advisory Committee for Photometry ; and Mr M. de Haas (Netherlands)—Advisory Committee for thermometry.

THE CENTRE OF OUR MILKY WAY

RECENT observations of W. Baade and his associates at the Mt. Wilson Observatory are reported (*Sky & Telescope*, April 1947) to have thrown further light on the structure and the central position of our galactic system, the study of which has always been rendered difficult by the obscuring clouds of dust and gas. In course of his study, Dr Baade has discovered a nuclear bulge which strongly suggests that the central region of our galactic system is composed of stars similar to those found in the centre of the Andromeda nebula.

Photographs were taken with the Observatory's 100-inch telescope with red-sensitive plates. In Sagittarius, the photographs reveal a high star density and record more than 400 variable stars per square degree. This figure surpasses the numbers previously observed by a factory of about 30. These variables are mostly of the cluster-type Cepheids such as are found in small numbers at low galactic latitudes and are approximately at the same distance from us. The distance of these group of variables has been provisionally measured and reported to be 9 kiloparsecs. Moreover, the maximum magnitudes of most of them lie between 16·5 and 18·0.

These observations clearly suggest that the region studied is a part of the galactic nucleus, about 5 degrees from the presumed centre. Like the centre of the Andromeda, the central region of our galactic system also appears to be composed of star of about the same nature.

Dr Baade has also determined the diameter of the Andromeda nebula from studies of B stars and open clusters and gives a value of about 20 kiloparsecs (65,000 light-years). This value compares well with the diameter of our own galactic system.

LYSOZYME

ACCORDING to a report of the *Technology Review*, an enzyme having the same activity as lysozyme found in the whites of hen's eggs and the tears of human eyes has recently been isolated from the latex of Central American trees of the *Ficus* germs. Lysozen as found in the white of the egg and in human tears is an enzyme well-known for its destructive action on bacteria by 'lying' or dissolving the bacterial cell wall. Lysozen thus offers good protection to the embryo against bacteria penetrating the shell from outside during hatching and also helps in the preservation of eggs when used as human food. Its presence in the tears considerably helps in protecting the exposed and delicate eyes from invading bacteria.

Lysozyme found in the trees of *Ficus* germs, however, differs chemically from the one of animal origin mentioned. Moreover, its exact role in the plant has not yet been ascertained. It is believed that either it may act as an antibiotic or may play some role as a metabolic agent such as the polysaccharides of the bacterial cell wall do in plant metabolism.

What is important about the lysozyme is the possibility of its being used as a clinical antibiotic like penicillin or sterptomycin. Recently, this possibility has been suggested from several competent quarters, and should it materialize, it would mean a new kind of control of infection. The biological activity of lysozyme, like other enzymes and also the vitamins, has already been recognized and studied in mixed preparations. Now that it has been isolated in pure crystalline form, further studies regarding the chemical and biological behaviour of lysozyme appear to be inviting.

LIQUID THERMOMETER FOR HIGH TEMPERATURES

Scientific American reports the successful development of a thermometer for recording high temperatures up to 1200°F, which is as convenient and quick-reading as ordinary clinical thermometers. Thermometric substance is liquid gallium (melting point 100°F) which is contained in a quartz capillary enclosed in a quartz envelope. Gallium used contains a slight trace of iron, but is otherwise pure. The use of this thermometer is generally recommended for the temperature range from 950° to 1000°F, a range which hitherto lent only to such indirect means as resistance thermometers, thermo-couples or pyrometers. Now this range can be directly explored by the liquid gallium thermometer which, before long, bids fair to be a highly useful instrument in the metals, ceramics and similar other industries.

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

THE Annual Report of the Indian Association for the Cultivation of Science for the year 1946 contains an account of the research work by the Mahendralal Sircar Professor. Owing to abnormal conditions in Calcutta, research activities suffered greatly and could be carried out with difficulty.

Study of molecular disorder inside crystal lattice has received great attention in the year under review. From the detailed study of the extra reflection of X-ray from various crystals it has been found that there are three distinct types of effects. The peculiarities of the sharp type of extra spots of phloroglucine dihydrate and the extra reflections due to planar derangement waves in benzil that were experimentally observed during the recent years have been explained quite satisfactorily by assuming that the infra-red oscillations excited by the incident X-ray beam in certain favourable cases such as diamond, phloroglucine dihydrate and benzil give rise to forced elastic oscillations inside the crystals. Effect of high temperature on the sharp extra spots of phloroglucine dihydrate has been studied and the results fit nicely into the theory. The intensities of the extra reflections of benzil at different orientations have been measured with the help of a photometer of the Robinson type constructed at the Association and a complete picture of the Fourier transform has thus been obtained.

Diffuse extra spots of thermal origin have also been studied in the case of pyrene at different orientations and the isodiffusion surfaces have shown some very interesting features.

Some interesting results have been obtained from X-ray investigations of glass systems by the X-ray diffraction method. Platinum dispersed in Lindemann glass does not produce devitrification, as was found in the cases of borax and B_2O_3 glasses by the X-ray powder diffraction method. X-ray investigations were extended to some coloured glass in which also no devitrification was observed.

The nature of the minerals present in coal samples has been studied by taking radiograms of thin sections and thus the distribution of minerals of appreciable particle size was studied. Powder photographs of these coal samples have also been taken so as to determine the identities of these minerals. Measurements of the electrical conductivities of well-developed single crystals of molybdenite along the *c*-axis and at right angles to the axis from the temperature of the liquid air to about 300°C. have shown that the conductivity of molybdenite at higher temperatures is predominantly electronic. This confirms the results obtained earlier from the studies of the magnetic anisotropy.

The fluorescence and absorption spectra of pure single crystals of anthracene, phenanthrene and pyrene as well as napthacene in solid solution in anthracene and crysene at different temperatures from 70°C. to liquid air temperature have yielded interesting results which are expected to be helpful in understanding the mechanism of fluorescence. The absorption and fluorescence spectra of anthrascene, perylene, phenanthrene, napthacene and pyrene in different solvents have also been studied and the positions of their maximum intensities have been measured with the help of a microphotometer.

INDIAN MINERALS

We have much pleasure in bringing to the notice of our readers the first number of the *Indian Minerals*, a quarterly journal of geological and mineral information, issued by the Mineral Information Bureau of the Geological Survey of India. Although no editorial note laying down the aims and objects of the publication prefaced the journal, its main objective appears to be promotion of public interest in geology and mineral resources of this country. The importance of a semi-popular journal of this nature need hardly be overestimated. So far only the specialist few had the privilege of having authoritative mineral information through the memoirs, bulletins, records, and such other special publications of the Geological Survey of India, to which the ordinary public, however interested, had little or no access. The public had, therefore, to be content with such information as scientific periodicals like ours occasionally thought fit to serve. The *Indian Minerals* will no doubt remove a long felt need and play an effective part in the geological and mineral education of the public.

The leading article "The Mineral Wealth of India" has done well in attempting to give a bird's eye view of the present mineral resources of the country, the values in rupees of the most important minerals being mined today, the minerals of which India's exportable surpluses are of world importance, and also of minerals in which India is either self-sufficient or dependent on foreign supply. Short notes on some of the important minerals mined in India, *e.g.*, iron-ore, titanium, thorium, mica, bauxite, manganese, magnesite, steatite, gypsum, monazite, beryl, coal, gold, copper, chromite, limestone, antimony, vanadium, silver, nickel and petroleum will be found extremely helpful to the uninitiated reader. Other articles include a review of the 'Indian Coalfields' Committee; "Petroleum in India" by J. Coates; "Zawar Silver-Lead-Zinc Mines" and "Emeralds in Mewar" both by H. Crookshank; "the Mineral Production of India during 1944" by the Director, Geological Survey; and "The Utilization of the Mineral Springs in India". Special section on "Topical News", "Scientific News and Notes", "Mineral Digest" and "Trade and Commercial Intelligence" are important features of the quarterly. The journal is issued by the Mineral Information Bureau, 27, Chowringhee, Calcutta, and all enquiries relating to subscription etc. should be made to the Manager of Publication, Civil Lines, Delhi.

RICE STUDY GROUP

The plenary session of the first International Rice Study Group, constituted under the auspices of the FAO was held at Trivandrum (India) from May 16 to June 6 last. The conference was attended by 50 delegates and observers representing Australia, Burma, China, France, India, Netherlands, Philippines, Siam, U. K., U. N. O. and U. S. A.

Mr S. Y. Krishnaswami (India) was elected as Chairman of the conference.

The conference made a detailed survey of production, trends and potentialities and assessed the possibilities of producing additional rice and recommended the establishment of a Central Rice Board for S.E. Asia.

It is estimated that in 1950-51 Burma will have a surplus of 2·75 million metric tons of rice and rice products, French Indo-China 0·75 million and Siam one million, while India will be deficit by 2·75 million tons.

The conference further recommended:

(1) that with a view to saving as much rice as possible from storage, depreciation and infestation, rice be stored in the form of well-dried paddy, a large percentage of rice supply should be parboiled since it keeps in good condition for long periods, and consumption of parboiled rice should be encouraged as it has distinct advantages over lightly milled or hand-pounded rice.

(2) that the FAO should call an urgent meeting of nutritional experts who have specialized in rice to initiate studies to determine the comparative values of different types of rice and to recommend the most suitable method of conserving and enhancing the value of rice.

(3) to the International Emergency Food Council that further allocations of nitrogenous fertilizers intended for rice production in S.E. Asia should consist of sulphate of ammonia in preference to other forms of chemical nitrogen.

(4) that credit at low rates of interest both short and long term, should be provided in all rice-producing countries in Asia to meet the bona fide needs of cultivators.

The conference further urged Governments to concentrate on irrigation and drainage projects and held that the International system of rice allocation should continue, as rice would continue to be in acute short supply for a number of years.

A working draft of the conference was prepared by three sub-committees, *e.g.*,

(1) On expansion of production, presided over by Mr W. H. Cummings (U.S.A.),

(2) On marketing prices and consumption presided over by Mr Vanderfloof (Netherlands) and

(3) On international trade presided over by Mr Phran N. Chammons (France).

Inaugurating the conference, Dr Rajendra Prasad, Food Member of the Government of India, indicated the lines along which the group should work to secure maximum results. Owing to rust extending over vast tracts, something like 1,500,000 to 2,000,000 tons of wheat had been lost and a serious situation was facing them. The provinces and States which in the past had supplied their surpluses to deficit areas, were now hard pressed for food grains for their own consumption and difficult times were ahead. The Food Member expressed the hope that the labours of the Rice Study Group would help in the improvement of India's food position and enable the country to secure whatever it could from other countries, especially those having large surpluses at their disposal.

The report of the Rice Study Group will be considered by an International Rice Conference to be held later this year, and by the next annual conference of the FAO.

Mr S. V. Krishnaswami, chairman of the conference in a statement said that the conference "marks an important step forward in the understanding of the several problems of production, internal storage and distribution and international action in regard to rice." Although rice formed the food of half the people of the world, it had not yet received the attention it deserved. "This is probably due to the fact that much of it is grown under conditions of a subsistence economy by small farmers and that it is the food of peoples who have been economically backward and politically unable to express themselves independently."

INTERNATIONAL CONGRESSES

The Fourth International Congress for Microbiology will be held in Copenhagen, July 20—26, 1947 under the presidency of Th. Madsen. There will be nine sections: Gen. Microbiology, Med. and Vet. Bact., Viruses, Serology and Immunology, Variation and Mutation in Micro-organisms, Plant Pathology and Mycology, Water and soil microbiology, Dairy and Food microbiology, and Alcoholic and other fermentations. The secretary, Dr M. Bjrneboe may be reached at the Kommunehospitalet, Copenhagen, Denmark.

The Sixth International Congress on Experimental Cell Research will be held in Stockholm, July 10—16, 1947, under the presidency of Mr J. Runnström, of the Wennergrens Institute. The conference will include a number of symposia on problems in experimental cell research from physicochemical, physiological and morphological aspects. Messrs T. Caspersou and H. Hyden, of the Karolonska Institute will act as secretaries.

The Thirteenth International Congress of Zoology will be held in Paris during 1948. Mr E. Fischer-Piette, the general secretary, laboratory of Malacologie, 55, Rue de Buffon, Paris V, urgently asks the directors of all zoological institutions to send him a complete list of the members of their staff in order that he will be able to inform all colleagues well about the congress.

The Eighth International Congress of Entomology will meet at Stockholm, August 1948 under the presidency of Y. Sjöstedt. V. Butovitsch will be general secretary. The date will be so arranged as not to conflict with that of the Zoological and Genetical Congresses which will be held at about the same time.

The Seventh International Physiological Congress will be held in Oxford (England), July 22—25, 1947 under the presidency of Sir Henry Dale. Dr E. W. Geidt, University laboratory of Physiology, Oxford is the secretary.

The Tenth International Ornithological Congress (originally planned in 1942 in Philadelphia) will be held after 1947 in the U. S. A., under the presidency of A. Wetmore. L. Griscom of the Harvard Museum of Comparative Zoology is the secretary.

The Seventh International Botanical Congress will be held in Stockholm in July, 1950 under the presidency of C. Skottsberg. Prof. H. Osvald, College of Agriculture, Uppsala, continues as secretary.

The Eighth International Congress of Genetics will also be held in Stockholm in 1948. Prof. G. Bonnier, Uppsala is the secretary.

The Fifth International Grassland Congress will be held in the Netherlands in June-July, 1949. Mr C. K. Van Daalen, Bilthoven, Neth., is the secretary. The congress will chiefly deal with grassland problems of regions with a temperate climate. There will be five sections: (1) Fodder values of pastures and Fodder conservation; (2) Genetics, Breeding and Seed production; (3) Grassland Sociology and Ecology, Botanical analysis of grassland; (4) Making,

management and utilization of grassland, farm organization questions: (5) Soils and manuring.

The Eleventh International Congress of Pure and Applied Chemistry, will be held in London on July 17, and India likely to be represented by Sir S. S. Bhatnagar, Sir J. C. Ghosh and Dr S. Krishna. Atomic energy will be among the subjects for discussion.

JOHN HUTCHINSON

THE election of Dr John Hutchinson, LL.D., F.L.S., V.M.H., a Kew systematist to the Fellowship of the Royal Society, is indeed not only an appreciation of his work on Botany but also an appreciation of Systematic Biology or Taxonomy as an important part of fundamental biological science by the scientists in general. Dr Hutchinson served for sometime as Assistant for India at Kew and later served in the African section. But his name is familiar to every student of Botany through his well-known books "The Families of Flowering Plants", Vol. I (1926) and Vol. II (1934), wherein he has introduced a new phylogenetic system of classification of plants and further suggested the polyphyletic origin of the dicotyledons from primitive herbaceous and arborescent groups. Dr Hutchinson is now 63 and two of his latest publications testify to his enduring interest in taxonomy. His Pelican Book entitled 'Common Wild Flowers' (1945) of Great Britain is written for the amateur who are interested in the plants of a countryside. Dr Hutchinson undertook two botanical explorations in South Africa during 1928-30 and was accompanied by General (now Field-Marshall) Smuts, a keen botanist, of which an account is given in his publication entitled 'A Botanist in South Africa' (1946).

BULLETIN OF THE BOTANICAL SOCIETY OF BENGAL

FOUNDED in 1935, the Botanical Society of Bengal, has rendered useful service by providing a forum for the discussion of papers communicated to the society by the members. From the very beginning the society wanted to have its own journal for the quick publication of the papers read before the society by its members but owing to the war and other factors beyond control, the society was unable to help its members with a journal. We are now in receipt of the first number of a 'Bulletin' of the society (April, 1947), which at once indicate the growth of an active school of botanical research in this province. Apart from the presidential address of Prof. S. R. Bose (see *Science and Culture*, May, 1947, p. 544), the bulletin include papers on a wide range of subjects. There are 3 papers in physiology, 2 in taxonomy, 1 each in anatomy, cytology and fossil microflora. Of these 'a list of the higher fungus flora of Calcutta and its suburbs',—an up-to-date list of 180 species of fungi with their synonyms and habitat,—is the result of sustained field work for a number of years by an active group of Calcutta mycologists. Working under the inspiring guidance of Prof. S. R. Bose, cytological basis for the incompatibility between *Cosmos bipinnatus* and *C. sulphureus* is determined by A. K. Sharma. These plants failed to hybridize at the garden of the Royal Agri-horticultural Society of India and the work was taken up at their suggestion. Microfossils in Chope coalfield (Bihar) by A. K. Ghosh *et al* opens up a new field of investigation in coal geology of India. The bulletin will now be published twice a year and we have every hope that the society would be able to provide a regular and quicker means of publishing the works done by its members, which is the defect unfortunately in so many of our scientific journals published in India.

NEW DRUGS FOR T. B. AND TYPHUS

MISS Nancy Atkinson, a bacteriologist of the Institute of Medical and Veterinary Science, Adelaide (South Australia) has extracted from mushrooms and toadstools new drugs that may prove effective in the fight against tuberculosis and typhus.

She found anti-bacterial activity in about 40 plants out of 450 flowering plants and more than 200 variety of mushrooms and toadstools examined by her.

In *Psalliota* sp (mushroom) and *Cortinarius rotundisporus* (toadstool), she found anti-bacterial activity against a wide range of bacteria, including the one that causes typhus. In *Psalliota* (=*Agaricus*) sp, she found a substance which killed tuberculosis bacteria in a test tube and attacked a wider range of bacteria than penicillin.

Encouraged by the laboratory results, Miss Atkinson plans to inject tuberculosis bacteria into guinea pigs and then to attempt to cure the animals with the mushroom extract. If these tests are successful, tubercular patients will be asked to volunteer for injections.

So far, Miss Atkinson has not been able to get enough mushrooms for this work but she is hoping to have two or three tons next September.

"Five pounds of mushrooms produce less than one pound of dried extract," says Miss Atkinson. "We get this by grinding the mushrooms, straining the thick brown fluid through muslin, and drying it by freezing in a vacuum at a temperature of 20° below zero. From 50 lb. of dried extract we hope to isolate about half an ounce of this new antiseptic.

Thus, we need about 250 lb. of mushrooms to get half an ounce of this new antiseptic, which may prove to be an entirely new chemical compound. We could use tons of them, and we will be appealing to the public for help." (*Medical Newsletter*, Australia).

DR PRAFULLA CHANDRA GHOSH

ACCEPTING an invitation from His Excellency the Governor of Bengal, to form a ministry for the new province of West Bengal, Dr P. C. Ghosh, M.A., Ph.D., has formed the new ministry of which he is the Chief Minister.

Educated at Dacca, Dr Ghosh a Calcutta University alumnus, graduated in Arts with first class Honours in Chemistry, from Dacca College (now defunct) standing first in order of merit, in 1913 and also took his master's degree in chemistry, standing first in first class, in 1916.

In 1920, Dr Ghosh submitted a thesis for his doctorate on 'Synthetic and Natural dyes' and he worked under Prof. E. R. Watson, D.Sc., of Dacca College.

He served for sometime as a Demonstrator in Chemistry, Presidency College, Calcutta and later his services were placed at the disposal of the Currency Department, in 1920 as Deputy Assay Master, Calcutta Mint

He resigned the appointment in 1921, and has since then served for the cause of the country. He is one of the founders of '*Abhoy Ashram*', at Comilla, an institution well known for its constructive work.

ANNOUNCEMENTS

DR T. S. Raghavan, formerly Professor of Botany, Annamalai University, has been appointed Botanist to the Coconut Research scheme, Ceylon. Dr Raghavan has specialized in cytology and cytogenetics and recently synthesized a new species of sesamum by hybridizing *Sesamum orientale S. prostratum.* The hybrid obtained was sterile but artificially rendered fertile through the induction of amphidiploidy.

Dr P. C. Biswas, lecturer in Anthropology, Calcutta University, has been appointed Reader in Anthropology and Head of the newly created department of Anthropology in the Delhi University. Dr Biswas has specialized in Physical Anthropology specially in finger palmar and foot prints and published a large number of papers in reputed journals in India and abroad.

Dr S. N. Das Gupta M.Sc., Ph.D. (Lond.), Reader in Botany, Lucknow University and President, Indian Botanical Society, is also to join UNESCO, early in July as one of its counsellors for the section of agriculture.

Miss Priti Mitra, M.A. of Calcutta has already joined the same organization in the Social Welfare Section.

Mr S. N. Sen, Registrar, Indian Association for the Cultivation of Science and one of the editorial collaborators of *Science and Culture*, has been appointed a Special Technical Assistant of the United Nations Educational, Scientific and Cultural Organization (UNESCO) at Paris. Mr Sen has left India early in July.

SIR C. V. Raman has been elected a corresponding member of the Academy of Sciences, U.S.S.R. Dr Raman is likely to attend a meeting of the Academy.

ERRATA

In April, 1947 issue p. 504, first column, line 8 *read* 0"·00070 *for* 0"·0070. In June, 1947 issue p. 599, second column, lines 7 and 19 *read* $C_{29}H_{50}O$ *for* $C_{29}H_{50}$.

BOOK REVIEWS

Milk of Paradise—By Forrest Reid. Faber & Faber, Ltd., London. Pp. 80. Price 6s. net.

Next to the pleasure of tasting old favourites in the solitude of one's relaxation, one loves to enjoy them in company with a connoisseur, and hear his comments *sotto voce*, and then even disagreement with his views renders one's own personal reactions sharper and more agreeable. That is the sort of pleasure that Mr Reid gives us in this series of talks which he modestly addresses to young people, but which we who are no longer young overhear with no less delight. He talks to us about what others have said about poetry,—'a kind of inarticulate, unfathomable speech', said Carlyle, 'a touch from behind the curtain', said Yeats—and then he reads to us Vaughan's *Retreat* and Traherne's *Salutation*, and when he reminds us in passing that what matters in poetry is not the objective validity of truths demonstrable to the senses but the integrity of the fundamental experience of which it is the authentic voice, not only does our understanding of Carlyle or Yeats becomes more immediate, but our surrender to alien experiences like that of Vaughan or of Wordsworth becomes far more satisfying. Even a poem like Lucy Gray gains under this sort of treatment ; we are reminded of Wordsworth's theory of poetry, and then shown how the most 'flat and humdrum landscape' acquires a certain mystic quality in the last stanza when it is interpenetrated by a beam of dazzling light, and the clouds part above it, and all is bathed in a soft glowing radiance." Mr Reid by his charm of style and perpetual zest in the poetry will certainly give pleasure to all those to whom poetry is indeed an incantation that evokes through the spell of mere words the richest emotions from the depths of a mind encrusted with layers of irrelevant matter.

D. G.

I Talk of Dreams, an experiment in autobiography—By Kenneth Walker. Jonathan Cape, London, 1946. Pp. 219. Price 10*s.* 6*d*.

The object of writing this book is made clear by the writer in his words, "This is no ordinary autobiography . . . . Like a teacher of biology, I illustrate the laws of living by showing them at work in the actual animal, but in this case I am not only the demonstrator, but the object which he demonstrates." This is as far the introspective way of looking on his own self is concerned.

With regards to the 'self', the writer feels that he has 'been lived rather than' he has 'lived'. "That arch-schemer and arch-flatterer, erroneously termed my ego, has taken possession of my being and used it for his own purpose." The writer thus gives a broad hint as to what the readers would be expected to find on reading this autobiography.

A person who possesses more than an average share of man's energy, opportunities for education and culture, and who tends to look at his ego driving him from one corner of the globe to the other is called in the language of parlance 'adventurer'. The book, in fact, proves this assumption.

His ego-ideal, the writer believes, was made up of four 'characters' which had impressed upon him the most during his childhood: the Red Indian's "contempt for the amenities of life", the Scottish Knight of St. Andrews, like whom he had dedicated himself to a noble cause and a life of celebacy, martyrdom of a missionary—Dr Paton and lastly, Greatness of Nietzchean tinge. After reading these 'four chief characters' the reader would be justified in taking a deep breath and wait for further flashes on the screen. But disappointment results on coming across what may be termed as travelogue instead.

One who is bent upon a life of martyrdom and greatness need not pursue such a life in reality, imagination—according to the findings of psychology—can compensate a good deal.

The adventures, as the writer believes, lay in Alpine climbing, game hunting in Africa, visit to India, set up a practice in medicine in Buenos Aires and volunteering to the World War I as a non-combatant officer. His comrade-in-arms in the war, Snoddy, had most probably seen him through the glasses of realism. "Tell me old idiot" once Snoddy asked him "why don't you get out of all this mess and do your proper job at the base?" He could not, his ego had him.

The book was written long ago, the present editon is only republished with a few changes. It is but natural to expect that it might have made an excellent reading before the World War II. But the world of 1947 is a far cry from the World before 1936. Realities of life today are too strong to be confused by the most realistic but nonetheless dreams. Consequently an 'experiment' in autobiography which might have proved to be a success to many,

even a decade ago, might carry the danger of proving to the contrary by the most. People of the world today are making history by complete living and would detest of going back to the pre-war days when most of us 'used to be lived stead of living'.

N. M.

Atomic Energy in Cosmic and Human Life—By George Gamow. Published by Cambridge University Press, 1947.

This is a popular book presenting in simple non-technical language, a short history of the development of nuclear physics from the discovery of radioactivity to the Bikini atomic explosion. The author, George Gamow, who has contributed a great deal to our present knowledge of the nucleus is also a well known and successful exponent of popular physics. He won a wide reading public with his two books of "Mr Tompkins" in which he dealt with the intricacies of quantum physics and nuclear physics in an extremely lucid and genial way. The present book, although it lacks, somewhat the author's earlier genial and humorous presentation, is a readable and interesting monograph. The care that the author has taken towards the accuracy of his statements has in no way interfered with the lucidity of his style or the continuity of his presentation. The variety of fare, to mention a few, includes Bethe's theory of thermonuclear reactions as a stellar energy source, the atomic pile, isotope separation, probable uses of atomic energy for rocket propulsion. The pile, as is natural, is well explained with a number of interesting diagrams. This is about the best popular exposition that the reviewer has seen of the fusion pile and allied subjects. The earlier part of the book which deals with ordinary nuclear reactions are presented historically and well accounted from Rutherford's discovery of splitting of nitrogen by α-particles to Lawrence's Cyclotron. The nerve and gusto of Mr Tomkins is however somewhat lacking, perhaps due to the speed at which the book had to be written and published. The book is to be commended as essential reading for all those who would desire to know about atomic energy.

B. D. N. C.

LETTERS TO THE EDITOR

[*The Editors are not responsible for the views expressed in the letters.*]

FRONTS IN TROPICAL STORMS

SINCE the general acceptance of the theory of Bjerknes of the origin of temperate latitude cyclones from waves at fronts, there have been many attempts by different authors (Roy & Roy, Ramanathan, Mal & Desai, Depperman, Bergeror, Schofield) to establish that tropical storms also originate from similar fronts. Attempts have also been made to identify the fronts in developed tropical storms. These attempts have, however, been made mainly with the help of surface data. In this note it is poposed to examine the question of fronts in developed storms with the help of some recent upper air data.

In November 1946 two tropical storms crossed inland from Bay of Bengal into south India, the first storm about 160 miles south of Madras and the second about 80 miles north of Madras. During that period daily radiosonde observations are available from Madras. The tracks of the two storms are given in Fig. 1.

A time-pressure (altitude) cross section for the period 31-10-1946 to 10-11-1946 is shown in Fig. 2. The temperature (in degrees centigrade) at each reported pressure level is plotted to the left and humidity mixing ratio (in gms/kilograms) to the right. Percentage relative humidity in tens is given in brackets. All the radiosonde ascents were at 1500 G.M.T. Pibal winds of 1100 G.M.T. are also shown on the cross section except on 1-11-1946 when the 1100 hrs. G.M.T. pibal ascent was a failure and the 0200 G.M.T. winds have been plotted.

Isotherms have been drawn on the cross-section by interpolating between reported levels. The isotherms are practically horizontal (upto 550 millibars —17,000 ft.), except from 31st to 1st between 850 and 700 millibars. The first storm was, however, more than 200 miles away from Madras at 1500 G.M.T. of 1st when the radiosonde ascent was made. The humidity variations from day to day are also within narrow limits except on 4th when the first storm was more than 400 miles from Madras and the second storm had not developed.

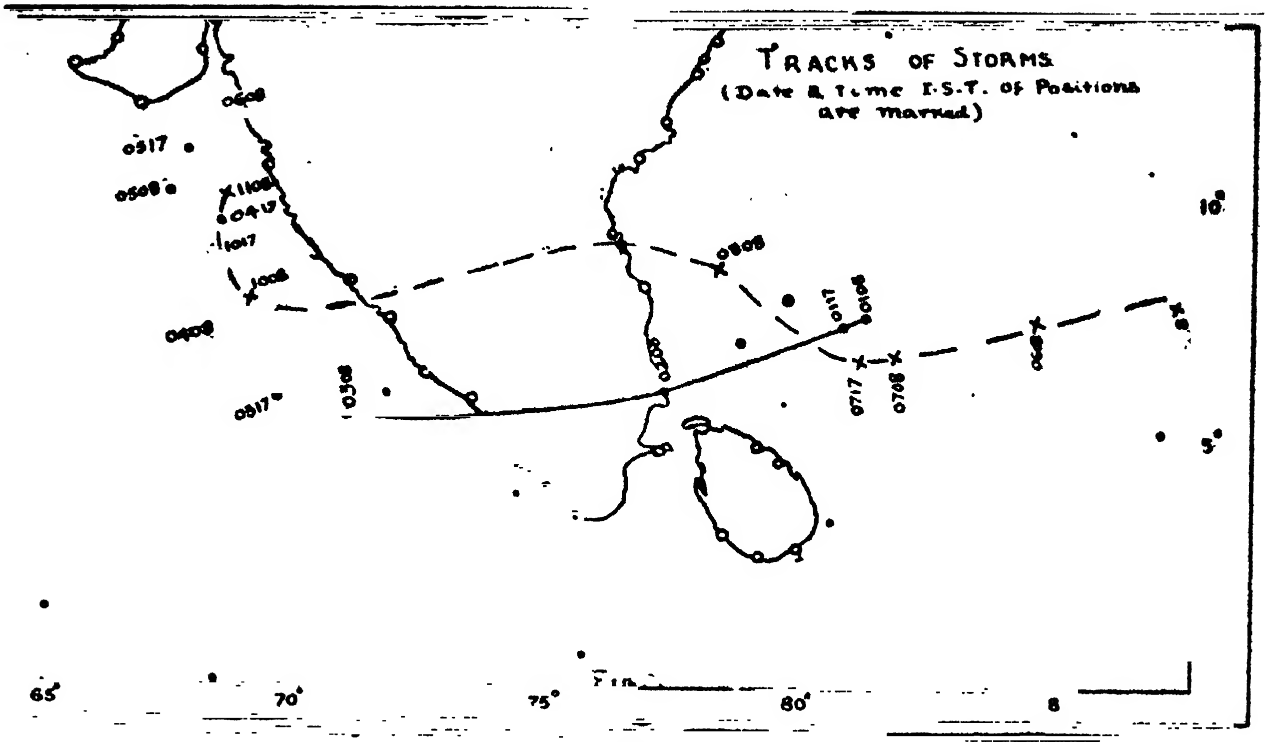

TRACKS OF STORMS
(Date & time I.S.T. of Positions are marked)
65°
70°
75°
80°
10°
5°

FIG. 1

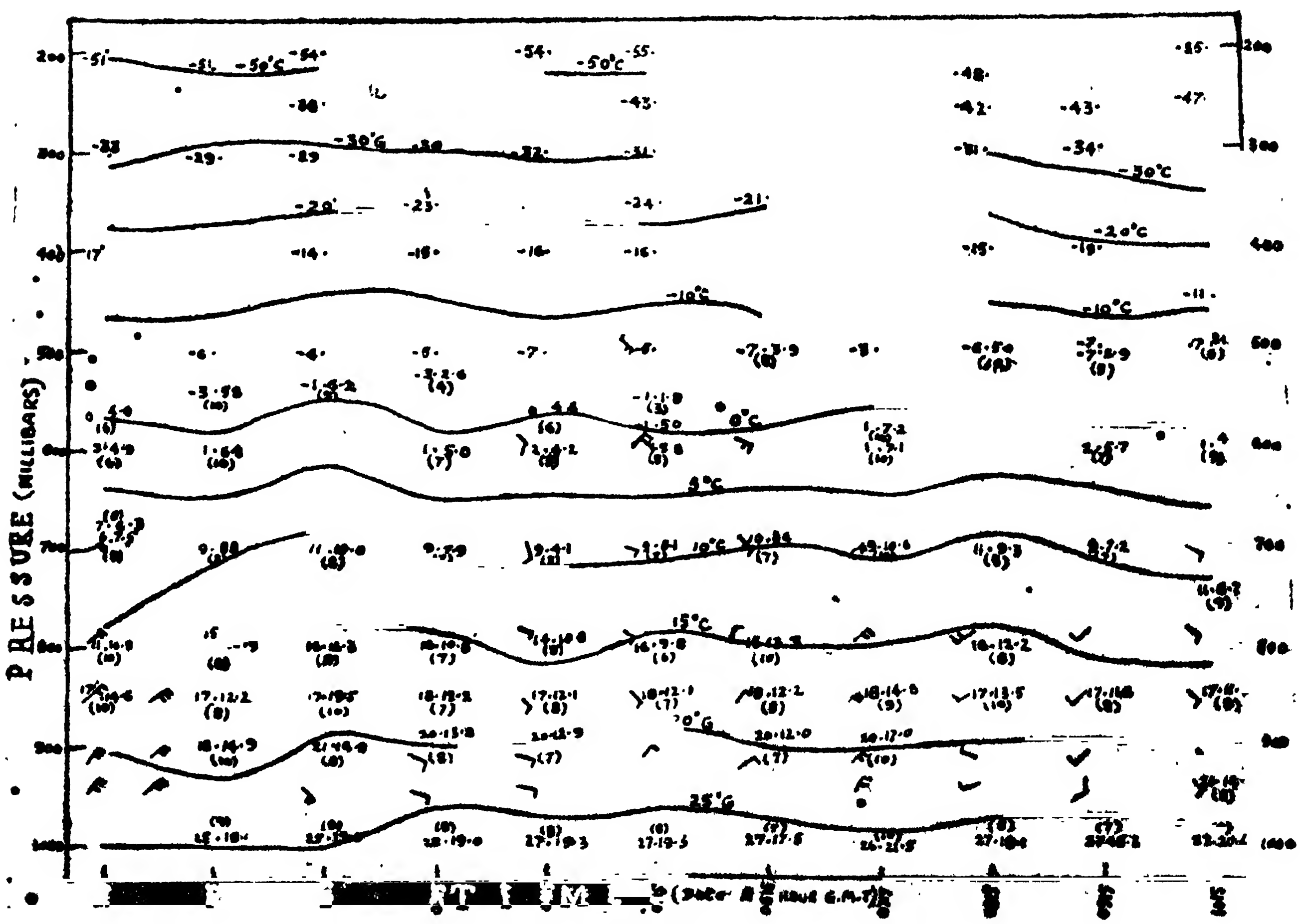

PRESSURE (MILLIBARS)
-50°C
-30°C
-20°C
-10°C
0°C
5°C
10°C
15°C
20°C
25°C

FIG. 2

Though one storm passed to the south of Madras and the other to the north, there is no evidence from the cross-section of change in airmass with contrast of temperature and humidity. It is hence reasonable to conclude that all round the centre of the storms for about 200 miles there were no fronts and there was only one practically homogeneous airmass. There are marked changes in wind direction from 1st to 2nd and from 7th to 8th but these are not associated with corresponding temperature or humidity changes. Hence an inference based on these wind shifts that fronts between different airmasses passed over the station would not be correct. It may hence be concluded that in these two storms there were no fronts within 200 miles from the centre.

Whether there are fronts with temperature and humidity contrasts giving rise to waves from which the tropical storms develop is a question about which no direct evidence is available from the data of the two storms discussed, but it appears that even if there were fronts and different air masses in the beginning, with the development of the storms, the fronts disappeared and the air masses got mixed up and became more or less homogeneous at least upto 200 miles of the centre.

S. K. PRAMANIK
Y. P. RAO

Regional Meteorological Centre,
Mehend Road, Karachi,
28-3-1947.

A NOTE ON THE LINEAR REACTION OF CELLULOSE-ACETATE

As a result of series of investigations on Cellulose-Acetate under different conditions of temperature, duration and catalyst, the author believes that very likely there is a mathematical relation existent between the per cent acetic acid content of an Acetate with the period of reaction. That relation has been found to be a linear one to be represented by the following formula :

$$Y = C + 1{\cdot}2\ X$$
$$X = \tfrac{1}{4}\ (C + 4 - Z)$$

where Y = percentage of Acetic Acid content.
X = per cent acetic acid content
Z = Total hours of reaction.
and C = A constant namely 48, which is the percentage Acetic Acid content of a true Di-Acetate.

Now if Z is known, we can easily find out the value of X and from that Y may be easily evaluated.

The following table comprising of cellulose-acetates having varying ratios of cellulose, acetic acid and acetic anhydride (1 : 4 : 4, 1 : 5 : 3, 1 : 5 : 4) as well as different percentages of H_2SO_4 as catalyst (from 11 to 20·2) will be convincing.

TABLE

Serial No.	Period of reaction in hrs. (Z)	% Acetic Acid obtained (Mean value experimental results)	% Acetic Acid obtained (Calculated from the formula)	% difference between the two
1.	4	62·4	62·4	Nil
2.	6	62·1	61·8	0·5
3.	8	61·3	61·2	0·2
4.	10	60 6	60·6	Nil
5.	12	60·0	60·0	Nil
6.	23	57·0	56·7	0·5
7.	24	58·8	56·4	4·3*
8.	25	57·6	56 1	2 6*
9.	26	57·6	55·8	3·2*
10.	27	55 8	55·5	0·5
11.	28	55 5	55·2	0·5
12.	29	55·2	54·9	0·5
13.	30	54·3	54·6	0·5
14.	32	53·7	54·0	0·5
15.	48	48·5	49·2	1·4
16.	55	46·5	47·1	1 3

The detailed paper will be soon published in the *Journal* of Indian Chemical Society.

Thanks are due to Dr M. N. Goswami, Head of the Department of Applied Chemistry and Dr S. C. Neogi, Lecturer Applied Chemistry Department, Calcutta University for their valuable suggestions and Messrs H. Datta & Sons Ltd. for their help and encouragement during the progress of the work.

P. K. CHOWDHURY

Indian Oil Plastics Laboratory,
India Oil Plastics Ltd.,
Calcutta, 30-4-1947.

* It has been found that the optimum condition of the reaction is between the temperature 40°—45°C. but the experiments 7, 8 & 9 although carried on at the optimum temperatures as specified above were kept overnight at ordinary temperatures 30°—32°C. instead of 40°—45°C. which account for the slowness of the reaction with corresponding increase in the per cent of Acetic Acid.

PERRIN PROCESS OF STEEL MAKING

THE Perrin Process of steel metallurgy roused much interest and experiments were carried in India. The Tata Iron & Steel Co. took the matter in hand and Mr B. Yaneski carried on protracted experiments at Jamshedpur on Perrin Dephosphorization with a view to utilize Tata Pig containing on an average ·28

to ·4 per cent phosphorus. It appears they hope to adopt this process suitably at Jamshedpur. The process as evolved by Mr Yaneski, is briefly stated here:

Pig Iron is blown in an acid converter and the blown metal is poured from a height of 21½ ft. into a basic, oxidizing, synthetic slag held in a ladle. The blown metal is thus churned and intimately mixed with the slag in the ladle. Phosphorus in steel is oxidized into phosphoric acid which is readily absorbed by the slag as $Ca_3(PO_4)_2$. The dephosphorization is very intense even for low P-content, the process being complete in the ladle in one minute for 15 tons of steel. The output of steel is increased with corresponding decrease in Iron oxide content in the slag.

The following data from one of Mr Yaneski's results illustrate the process—

the initial charges, however cautious, may help in reaching the standard of O.H. production. The steel is likely to be badly damaged, or at best, its quality will be uncertain.

The depth of a furnace has some bearing on the quality. The modern Open Hearth is 30″ to 40″ deep. Entangled solid particles have less freedom to separate in a deep bath of a ladle; also the time allowable for separation is obviously strictly limited. The likely effect is to increase the objectionable inclusions and lower quality of product.

It is interesting to make a reference to Duplex Talbot process, where a blown metal is poured over a similar slag and where oxidation is also very intense. But addition of fresh pig and a finishing heat enable the operator to overcome the difficulties likely in the Perrin.

Analysis of slag. (*Figures in percentage*)

	SiO_2	Al_2O_3	FeO	Fe_2O_3	MnO	CaO	MgO	P_2O_5
Before Mixing ...	6·5	1·5	17·8	22·18	·4	47·85	3·32	·51
After Mixing ...	18·2	3·04	21·15	4·58	2·48	41·35	2·05	5·95

	C	Mn	S	P	Si
Blown Metal	·16	·08	·026	·25	·03
After Dephosphorization ...	·08 ·07	·04	·031	·018 ·018	·032

Weight of slag: 10·0% of steel.

The process just outlined suggests some striking features. The basic heat is finished in a few minutes whereas the O.H. counterpart of a customary duplex process would require on an average about three hours. Apparently also, this process obviates the necessity of a costly furnace.

A critical examination shows that, fundamentally no new theory is employed in the composition and function of the slag; but the manner and technique of carrying out the reactions are quite novel. But unlike the O.H. operation, this process has no control over time, temperatures, order and extent of the reactions effected. The oxidation here is very intense and almost instantaneous, but there is no provision for checking the oxidation proceeding too far. An oxidizing treatment, not to speak of such intense oxidation, requires the metal to be carefully protected. It is a common knowledge that O.H. is so operated as to retain some carbon in the bath till dephosphorization is complete. The C is then slowly worked out, and any oxidizing influence beyond what is absolutely necessary being avoided. Such precautions though necessarily require time, enable the operator to produce quality steel. In contrast, intense oxidation, rapidity of process, low carbon in the bath in the Perrin's are all likely to make the steel highly charged with oxygen. No control over

It may be further pointed out that quality rather than quantity is the key note of success of any modern process. The Perrin Dephosphorization, as it stands, is unlikely to make any headway. It may be that the process may be suitably extended to a triplex process arranging to give the metal a final reducing heat.

P. C. Ghosh

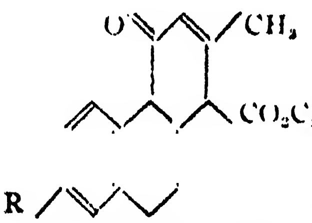
Jessore Road,
Khulna (Bengal).
23-5-1947.

STEROID COMPOUNDS. PART II[a]—STUDIES IN THE MICHAEL CONDENSATION OF 1-ACETYL-3:4-DIHYDRO NAPHTHALENE AND ACETOACETIC ESTER

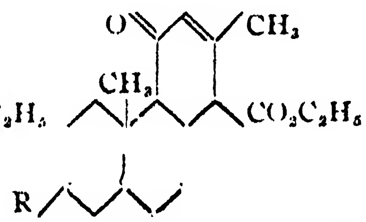
The following experiments were undertaken as a preliminary study with the object of building up phenanthrene derivatives of the type (I. R = OCH_3; II. R = OCH_3; H) which might prove valuable as intermediates in a projected scheme for the synthesis of oestrone and other steroid ketones.

1-Acetyl-3 : 4-dihydro naphthalene[1] obtained by the action of cadmium dimethyl on 3 : 4-dihydro

naphthoyl chloride was condensed with ethyl acetoacetate in presence of NaOE in alcohol to yield ethyl-2-methyl-4-keto-$\Delta^{2:3}$-hexahydrophenanthrene-1-carboxylate (colourless silky needles, m.p. 102-103°. Found: C—75·56, H—7·13, $C_{18}H_{20}O_3$ requires C—76·05, H—7·04 per cent). This on catalytic reduction in presence of Adam's catalyst in alcohol furnished ethyl - 2-methyl - 4-keto-octahydrophenanthrene-1-carboxylate as a colourless viscous oil (B.P. 183-84°/4 mm. Found: C—75·1, H—7·9, $C_{18}H_{22}O_3$ requires C -75·52, H- -7·69 per cent; oxime-m.p. 217°), which on hydrolysis with conc. HCl afforded a keto acid, 2-methyl-4-keto-octahydro phenanthrene-1-carboxylic acid (m.p. 187-189, shrinks—177°C). The isolation of a keto acid on the hydrolysis of the reduced ester conclusively proves the structure of the unsaturated keto ester as represented in (I.R.=H). Had the ring closure taken place in the other way the product of hydrolysis should have been a neutral ketone. It may be mentioned here that the above unsaturated keto ester (I. R.=H) as well as the saturated keto ester did not produce any colouration with ferric chloride in alcoholic solution.



(I) R=H ; OCH_3



(II) R=H ; OCH_3

Addition of HCN to the double bond of the unsaturated keto esters (I, R=OCH_3 ; II, R=H, OCH_3) and hydrolysis of the resulting cyano compound and subsequent reduction of the keto group will afford phenanthrene derivatives with two contiguous carboxyl group from which, by partial homologation of the secondary carboxyl group according to Arndt-Eistart reaction, it will be possible to build up the cyclopentane ring as carried out by Bachmann for the synthesis of trans-8-methyl-hydrindanone[2].

For this purpose the addition of HCN to simpler substances possessing the reactive features present in the tricyclic system (I) has been studied. Thus ethyl-2-methyl-4-keto-$\Delta^{2:3}$-octahydro naphthalene-1-carboxylate[3] smoothly added up the elements of HCN to yield ethyl-2-methyl-2-cyano-4-keto-decahydronaphthalene-1-carboxylate (b.p. 200°/7 mm. Found: N—5·16, $C_{15}H_{21}O_3N$ requires N—5·32). Similarly 3-methyl-4-carbethoxy-$\Delta^{2:3}$-cyclohexanone (Hageman's ester) added up HCN to yield 3-methyl-3-cyano-4-carbethoxy cyclohexanone (b.p. 135-37/3 mm. Found: N—6·77, $C_{11}H_{15}O_3N$ requires N—6·7 per cent; semicarbazone m.p. 210°C). The corresponding ethyl ester, diethyl-3-methyl-cyclohexanone-3:4-dicarboxylate (b.p. 128-132°/2·5 mm.) is readily obtained by passing dry HCl gas to a hot alcoholic solution of the nitrile.[5] The diethyl ester on hydrolysis and Clemmensen reduction furnished a crystalline solid acid which melted at 213°C. The cis- and trans- forms of 2-methylcyclohexane-1:2-dicarboxylic acid melt at 160°C and 213°C respectively[4]. It is therefore obvious that this new acid also belongs to the trans series and in the original keto nitrile the CN and CO_2Et groups also possess trans-configuration. Further work to confirm these evidences is being actively pursued.

It follows from the work of Linstead *et al*[3] that the tricyclic keto-esters (I & II) also possess the trans fusion of the rings B and C and if the addition of HCN to these keto esters also follow the above course which is very likely to give the CN and CO_2Et in trans position then it will be possible to build up the cyclopentane ring fused in trans position to the cyclohexane ring. The investigations are being continued in all its important aspects.

My thanks are due to Dr P. C. Mitter, M.A., Ph.D., for the keen interest he has taken during the course of this investigation, to Dr P. C. Dutt, D.Sc., for gifts of chemicals. My thanks are also due to Mr N. Ghosh, M.Sc. and Mr C. N. Bhar, M.Sc. for the micro-analysis of the compounds and to the University of Calcutta for the award of a Scholarship out of the Sir P. C. Ray Research Fellowship Funds.

PRATUL CHANDRA MUKHERJI

Sir P. C. Ray Research Fellow's Laboratory,
University College of Science,
92, Upper Circular Road, Calcutta.
24-5-1947.

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OBSERVATIONS ON THE STARCH-IODIDE COMPLEX

From the works of Rundle and French[1] and others, it is clear that water can cause starch to assume the V-form or the helical configuration. But it is not clear whether any other compound can do the same in the absence of water. The following experiments were therefore taken up:

(1) Powdered starch was taken in a mortar and an alcoholic solution of iodine added. On mixing no color developed but the small amount of starch

powder which happened to come out, during stirring, from the liquid and became exposed to air, were colored almost immediately blue. The possibility that oxygen of air may have any action was excluded by carefully aerating (*i*) an alcoholic suspension of starch, (*ii*) a solution of iodine in alcohol separately and also (*iii*) a mixture of starch and iodine in alcohol.

Next to remove the possibility of absorption of water from atmosphere by alcohol, we kept a mixture of pure methanol solution of iodine and starch inside a desiccator. After long periods of time when alcohol and much of the iodine has evaporated the starch is found to be colored deep black.

It appears, therefore, that alcohols can cause starch to attain the V-modification which alone colors with iodine (as contrast with other modifications, A, B, etc., Rundle and French *loc. cit*) independent of any presence of water but that the action is much more sluggish.

Property of this starch-iodide.—The excess iodine from the iodide complex was removed by benzene and it was then heated on the boiling water-bath with (*i*) alcohol, (*ii*) water. It was found that the compound maintains its color in presence of alcohol but becomes colorless in presence of water. The color, however, reappears on cooling. In these respects it is, therefore, identical with the complex formed in presence of water instead of alcohol.

(2) Non-hydroxylic solvents of iodine such as toluene, ether etc. were found to be incapable under similar circumstances of producing the iodide complex. It is imperative that specially pure samples of these substances must be used, those of ordinary make are liable to contain impurities, traces of which may suffice to mar the whole experiment. Thus it appears that compounds such as R-OH can generally cause starch to assume the helical configuration. But similar experiments as above with iso-amyl alcohol shows that there is a volume effect also and "bushy" alcohols tend to become incapable of giving rise to V-modification (*cf.* Bear[2]).

We next decided to determine what happens exactly, when starch-iodide is heated in presence of water. The iodide was prepared as follows: Iodine crystals were added to starch powder suspended in water and stirred continuously with a rod. Slowly the blue compound begins to form and it was left overnight so as to complete the formation of the iodide. This was then filtered off and allowed to dry perfectly in the atmosphere. Excess of iodine was then extracted by benzene and then the black powders were boiled with benzene on the water-bath. It was found that the benzene extracts no color and even on prolonged heating the color of starch-iodide persisted. It precludes, therefore, the idea of Personne[3] of loss of iodine and isomeric change into a colorless form by heat alone. It also makes improbable the solution theory of Freudenberg[4] and probably also the adsorption theory (Lottermoser[5], Dhar[6]) since benzene is so good a solvent for iodine. Now a few drops of water were poured into the test tube containing starch-iodide and benzene and it was placed in boiling water with frequent shaking. It was found that in a little time the iodide has been decolorised and benzene layer has become pink by dissolving iodine. On cooling the blue color does not reappear.

It appears, therefore, that water molecules actually replace the iodine molecules from the starch-iodide complex during heating and that the resulting aquo compound is colorless. The iodine, however, can regain its position on cooling so that the blue color comes back again. The displaced iodine remains in aqueous solution from which it can be extracted by benzene or toluene.

It would appear from the above that iodine is not possibly in solution or adsorbed by starch, for how can water in which iodine is only slightly soluble extract it from starch-iodide while a much better solvent as benzene, toluene or alcohol will not do the same. It is possible that iodine molecules if not chemically united in the strictest sense, is united by some sort of residual affinity of starch (*cf.* Rundle, Foster and Baldwin[7] and also Bates, French and Rundle[8]).

It has been found that when dry starch-iodide is mechanically shaken for long hours in benzene suspension with the requisite amount of a silver salt the blue color is discharged. Experiments are in progress to determine what becomes the fate of starch in these reactions.

I am thankful to Mr R. P. Chatterjee for supplying me with some specially purified chemicals.

A. K. RAI CHOUDHURY

Bio-chemical Laboratory,
Bose Research Institute,
Calcutta, 26-5-1947.

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ON THE SYNTHESIS OF BIGUANIDE ANTIMALARIALS

An idea is generally gaining ground that the cause of development of anti-malarial properties in a compound would depend much on their structures capable of certain tautomerism which might interfere with the enzyme systems involved in the metabolism of the malarial parasites[1,2]. The activity of quinoline, pyrimidine or biguanide antimalarials is most probably due to their conversion into some active form in the system (*cf.*, Schönhöfer[3] and Hawking[4]). The latter type of antimalarials (biguanides) again form a class of compounds whose structure is liable to much variation (*cf.*, Hughes[5]) and as such their properties may also differ considerably. The most important compound in this series is N'-p-chlorophenyl-N¹-*iso*-propyl biguanide (I) better known as "Paludrine". This has been synthesized by Das Gupta, *et al*[6] virtually by interaction of p-chloro-phenyl- and *iso* propyl-cyanamides in presence of ammonia (Process A). The other method of its preparation has been described by Curd and Rose[7] and this involves the condensation of p-chloro-phenyl cyanoguanidine with the base *iso* propylamine (Process B). An alternative process (C) would be the interaction of cyano-*iso*-propyl guanidine with p-chloroaniline. It would be a matter of considerable interest to study the difference in structure and properties of the compound as obtained by one or the other method.

$$
\left.\begin{array}{ll}
\text{Process A:} & Cl.C_6H_4.NH.CN + NH_4 + CN.NH.CH.Me_2 \\
\quad ,, \quad \text{B:} & Cl.C_6H_4.NH.C(:NH).NH.CN + NH_2CH.Me_2 \\
\quad ,, \quad \text{C;} & Cl.C_6H_4.NH_2 + CN.NH.C(:NH).NH.CH.Me_2
\end{array}\right\}
\begin{array}{c}
Cl.C_6H_4.NH.C:NH \\
| \\
NH \\
| \\
Me_2CH.NH.C:NH \\
\text{(I)}
\end{array}
$$

It is already known[8] that an aromatic amine salt reacts with dicyandiamide to form biguanide salt. The formation of the biguanide (I) by the Process C, might be accomplished by reacting p-chloroaniline hydrochloride with the cyano-*iso*-propyl guanidine obtainable by condensing cyanamide with cyano *iso*-propyl amide. The biguanide hydrochloride separates from water as colorless needles, m.p. 243°. The properties of the biguanide salt as obtained by the different processes would be the subject of discussion in subsequent study.

U. P. Basu

Bengal Immunity Research Laboratory,
Calcutta, 3-6-47.

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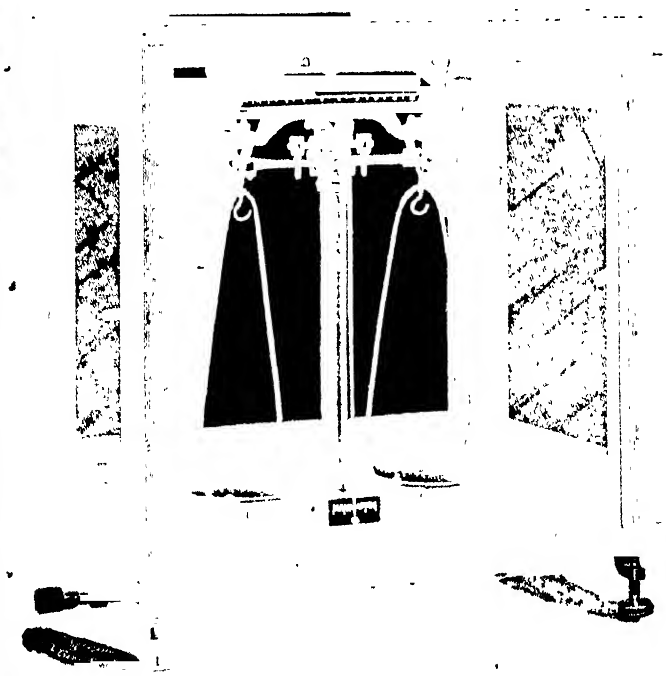

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SCIENCE AND CULTURE

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TECHNICAL EDUCATION

WE are glad that the shadow cast over the land by political dissensions has at last been lifted; and we hope that the minds of our leaders will not be deflected, by internal quarrels, from effectively handling the tasks which are intended for our common good. These tasks are more economic than political, and include those fundamental changes which would raise the standard of living of the common man in India. Eighty per cent of our people live as medieval peasants on subsistence of agriculture with its inevitable incidence of malnutrition, ignorance, disease, and even famine. A high official of the Department of Foreign Economic Administration in Washington is reported to have stated that if the 400 million country men of ours were to take a year's holiday, they could be provided with their present requirements of food and service by six million American workers transported to India with modern tools of production. Here is obviously the weakest spot in our economy—the wealth that a man creates with his primitive skill and ancient tools is insignificant compared with what a modern skilled worker can do with his up-to-date tools. In spite of what our saintly Mahatma may say, the future belongs to those who know how to use machines as slaves and not ask human and animal muscles to bear the strain which machines can bear. Our men and women, even from humblest homes, are gifted with a natural intelligence which is equal to that of an average American. They have inherited that intelligence from ancestors who built a civilization in this land 2000 years ago, which was the wonder of the world at that time. It is the arduous task of our technical institutions to equip the workers of India with modern skill and modern tools, so that they can create enough wealth to enjoy a fuller and more satisfying life.

Our country has got enough natural resources which are necessary for our schemes of economic and social betterment; but these resources will have to be developed with the maximum vision; intelligence and enterprise. Hence fully trained technical men hold the key position in all schemes of resource development. We cannot depend indefinitely on the import of foreign technical skill and industrial "know-how" to meet our demands. Indian industrialists know well how difficult and expensive it is to secure the service of really competent foreign technicians at the present time. It is also well-known that in most cases, foreign technical experts have demanded not only exorbitant remuneration but also a controlling influence in the concerns for which their services were required; and the Indian industrialists had often no option left but to accede to these demands. This is all the more reason that India should build up her higher technical force as speedily and expeditiously as possible.

The Russian planners realised very early that lack of technicians would be a bottleneck which would impede the progress of their schemes of resource development. They decided accordingly to train technical personnel on a gigantic scale. For example, in the early twenties, Prof. Joffe started the Physico-Technical Institute in Leningrad with a total personnel of three. He was asked by Lenin to collect promising young men from all parts of Russia who would be fed and trained at the cost of the State. There was no limitation of funds, but the Institute must expand its activities at a geometrical rate of progression. By 1928, the Institute had grown to immense size with 2000 teachers, students and workers. It is the men and women from such institutes that have chiefly been the brains and executives of the successive five year plans which were put in operation in 1928.

The Indian delegates to the Empire Science Conference in July last year had occasion to visit the

scientific and technial institutions of Great Britain; and they were impressed by the strenuous attempts that were being made there to develop technological manpower and resources to the limit of capacity. The United Kingdom has at its disposal a force of 55,000 qualified scientists and technologists. It is estimated that the demand for these men will increase to 90,000 by 1955. Hence the universities and technical colleges were being pressed to produce at least 4000 competent technologists every year and undertake at government expense the necessary expansion. The professors, everywhere, were busy in planning extensions of laboratories and workshops which were to be fitted with the most up-to-date equipment and apparatus. They were not worried about funds—the Labour Government would see to that—but they were rather worried about competent young collaborators coming forward in sufficient numbers to help them in their work.

In India, those who have to manage technical institutions are worried equally about funds and competent teachers. One of the editors had three years ago a S.O.S. call from the vice-chancellor of a neighbouring university, as a result of which he had to surrender to him his teacher in Chemical Engineering on seven days' notice; and a week ago, the vice-chancellor of another university came to his house and pressed him to repeat the same performance for his benefit. We are afraid, these difficulties about securing proper staff for our technical institutions will continue if a proper scheme for the training of such teachers is not taken in hand immediately. The Government of India have appointed a Committee to review the work that has been done for the training of scholars in overseas institutions. We should strongly recommend to this committee that this problem of training of teachers who would hold responsible positions in technological institutions should be carefully examined, and immediate steps be taken to remedy the situation.

In countries which have come out of this war with their political system fairly intact, it is universally felt that no expenditure of public funds can be too high which aims at training men of science and technology in sufficient numbers for successful execution of the post-war plans of development. We hope that the Central and Provincial Governments in India will have the vision to adopt a similar attitude. So far as higher technical education is concerned, the All-India Council of Technical Education at its recent meeting in Bangalore took the view, that it was a subject of all-India importance and that the Central Government should take a large share of the responsibility for maintaining these institutions on an efficient basis; they have therefore recommended that grants should be given direct by the Central Government to those institutions who fulfil the following conditions:

(a) The Institution must adopt a minimum standard salary scale for teachers—the scale to be laid down by the Council after taking into consideration the recommendations of the Central Advisory Board of Education and of the Pay Commission in this matter.

(b) The Institution must maintain a minimum standard of education as may be laid down by the Council.

(c) In the matter of appointment of teaching staff the Institution must arrange to associate with Selection Committees independent experts in the subjects concerned to the satisfaction of the Council.

(d) The Institution must agree to periodical inspections by the Council's authorised representative and render him every assistance to enable him to report whether the conditions laid down above are being complied with.

It also augurs well for the future, that the All-India Council of Technical Education are strongly in favour of central planning and control of higher technical education.

This Council is at present a purely advisory body. They have not yet been vested with any administrative power because of objection from Provinces and States. In welcoming the Council at Bangalore, the Dewan of Mysore, however, expressed the hope that this Council would before long be endowed with executive powers and that all parts of India would look to it in all matters relating to development of technological education. This view was endorsed unanimously by the Council at its Bangalore meeting which was attended, among others, by the Hon'ble Ministers of Education from Bengal and Sind; and recommendations are being made to Central Government accordingly. It was generally felt that the interests of higher technical education would be better looked after by an all-India autonomous organisation than by the Education Departments of Central and Provincial Governments who would be primarily concerned in the near future in organising a national system of universal basic and secondary education.

It is well to recognize that though we have in our midst a large number of capable men who have considerable knowledge of the general principles of science, we are extremely deficient in men who are familiar with the "know-how" of an industrial process. A qualified technologist should combine the knowledge of general scientific principles with their

special application to particular problem of production and utilisation. The All-India Council of Technical Education is naturally anxious to devise means for arranging adequate practical training facilities for technological students. In order that the practical training imparted in industrial establishments may be really useful, the Council feels, that it is necessary to attach liaison officers to approved industrial establishments, for the co-ordination and supervision of training programmes, and also to give remuneration to some of the staff in such establishments, who would be directly concerned with imparting of actual training. It has recommended that the Government of India, should compile a list of suitable factories where students may have a reasonable chance of receiving adequate training facilities. On receipt of this information, the Council will consider whether such practical training facilities cannot be shared by all institutions throughout the country by staggering the period of training and whether it will be desirable to approach suitable factories with such a proposal. We are sure that if this arrangement materialises it will be of considerable help to the principals of institutions in providing practical training for their students.

If we are short of technologists who are familiar with the industrial "know-how", we are still more short of men of ability who are capable of research and applying the results of research to resource development. It is only very rarely that Indian industrialists take a long view of things. They are generally satisfied with running their plant in accordance with instructions received from foreign makers at the time of purchasing the plant. This attitude is however, changing in view of the insuperable difficulties in the way of importing machine tools and industrial plants. We hope that these difficulties will prove a blessing in disguise; and that before long, our industrialists and political leaders will realise that they cannot build prosperity only on borrowed knowledge, "that the nation which will enjoy the benefits of science in the day-to-day progress of its industries is the nation which habitually applied to them scientific method and scientific knowledge; and it is that nation which will be able to seize the advantages of the more spectacular achievements of science in its economic life." Knowledge is power, but it is wielded by those who make early and rapid use of it in close contact with men who have created such knowledge. This is the lesson of recent history, and we should do well not to forget this lesson in developing our national life. Any proposal to provide facilities for postgraduate study and research in our technological institutions should receive our warmest support.

In the scheme of things to come, industries will be run in India by competent managers and not by financiers. It will be wise to anticipate that change and include in our Technical Colleges provision for management studies, so that technical men who aspire to positions of engineer-managers, may acquire early in their career the knowledge and training which would fit them for executive responsibility. We are glad to note that Government in the Department of Labour have appointed a committee which is examining the whole problem; their recommendations, we hope, will be of a far-reaching character and will make possible the rapid production of a cadre of able men who would form the core of management of our national enterprises and probably also of private enterprises.

It is heartening to note that the Hon'ble, the Defence Member, who will have considerable influence in shaping our future, should have made the following observation in his historic broadcast to the Nation on 3rd June: "We are poor, let us not forget that we have no apology to let poverty to continue to afflict our people, now that we shall be masters of our own affairs; we have tasks, big and small, of reconstruction on our hands; our people have many needs that have lingered unmet for years. Let us settle down to meet these needs and relieve the distress that haunts us. Let us grow above petty outlooks and work together to put our country on the way to greatness that certainly belongs to it. Above all, let us not lay a price on what is price-less—the willing surrender of our best for the common good of us all." May we all work up to this ideal!

ONLY THEN SHALL WE FIND COURAGE*

ALBERT EINSTEIN

MANY persons have inquired concerning a recent message of mine that 'a new type of thinking is essential if mankind is to survive and move to higher levels.'

Often in evolutionary processes a species must adapt to new conditions in order to survive. Today the atomic bomb has altered profoundly the nature of the world as we know it, and the human race consequently finds itself in a new habitat to which it must adapt its thinking.

In the light of new knowledge, a world authority and an eventual world state are not just desirable in the name of brotherhood, they are necessary for survival. In previous ages a nation's life and culture could be protected to some extent by the growth of armies in national competition. Today we must abandon competition and secure co-operation. This must be the central fact in all our considerations of international affairs; otherwise we face certain disaster. Past thinking and methods did not prevent world wars. Future thinking must prevent wars.

Modern war, the bomb, and other discoveries present us with revolutionary circumstances. Never before was it possible for any nation to make war on another without sending armies across borders. Now with rockets and atomic bombs no centre of population on the earth's surface is secure from surprise destruction in a single attack.

America has a temporary superiority in armament, but it is certain that we have no lasting secret. What nature tells one group of men, she will tell in time to any group interested and patient enough in asking the questions. But our temporary superiority gives this nation the tremendous responsibility of leading mankind's effort to surmount the crisis.

Being an ingenious people, Americans find it hard to believe there is no foreseeable defense against atomic bombs. But this is a basic fact. Scientists do not even know of any field which promises us any hope of adequate defence. The military-minded cling to old methods of thinking and one Army department has been surveying possibilities of going underground, and in wartime placing factories in places like Mammoth Cave. Others speak of dispersing our population centres into 'linear' or 'ribbon' cities.

Reasonable men with these new facts to consider refuse to contemplate a future in which our culture would attempt to survive in ribbons or in underground tombs. Neither is there reassurance in proposals to keep a hundred thousand men alert along the coasts scanning the sky with radar. There is no radar defense against the V-2, and should a 'defense' be developed after years of research, it is not humanly possible for any defense to be perfect. Should one rocket with atomic warhead strike Minneapolis, that city would look almost exactly like Nagasaki. Rifle bullets kill men, but atomic bombs kill cities. A tank is a defence against a bullet but there is no defence in science against the weapon which can destroy civilization.

Our defence is not in armaments, nor in science, nor in going underground. Our defence is in law and order.

Henceforth, every nation's foreign policy must be judged at every point by one consideration: does it lead us to a world of law and order or does it lead us back towards anarchy and death? I do not believe that we can prepare for war and at the same time prepare for a world community. When humanity holds in its hand the weapon with which it can commit suicide, I believe that to put more power into the gun is to increase the probability of disaster.

Remembering that our main consideration is to avoid this disaster, let us briefly consider international relations in the world today, and start with America. The war which began with Germany using weapons of unprecedented frightfulness against women and children ended with the United States using a supreme weapon killing thousands at one blow.

Many persons in other countries now look on America with great suspicion, not only for the bomb but because they fear she will become imperialistic. Before the recent turn in our policy I was sometimes not quite free from such fears myself.

Others might not fear Americans if they knew us as we know one another, honest and sober and neighbours. But in other countries they know that a sober nation can become drunk with victory.

We are still making bombs and the bombs are making hate and suspicion. We are keeping secrets and secrets breed distrust. I do not say we should now turn the secret of the bomb loose in the world, but are we ardently seeking a world in which there will be no need for bombs or secrets, a world in which science and men will be free?

* From *The New York Times Magazine*.

While we distrust Russia's secrecy and she distrusts ours, we walk together to certain doom.

The United Nations is the only instrument we have to work with in our struggle to achieve something better. But we have used U. N. and U. N. form and procedure to outvote the Russians on some occasions when the Russians were right. Yes, I do not think it is possible for any nation to be right all the time or wrong all the time. In all negotiations, whether over Spain, Argentina, Palestine, food or atomic energy, so long as we rely on procedure and keep the threat of military power, we are attempting to use old methods in a world which is changed for ever.

No one gainsays that the United Nations Organization at times gives great evidence of eventually justifying the desparate hope that millions have in it. But time is not given to us in solving the problems science and war have brought. Powerful forces in the political world are moving swiftly toward crisis. When we look back to the end of the war—it seems ten years ago! Many leaders express well the need for world authority and an eventual world government, but actual planning and action to this end have been appallingly slow.

Private organizations anticipate the future, but government agencies seem to live in the past. In working away from nationalism toward a supranationalism, for example, it is obvious that the national spirit will survive longer in armies than anywhere else. This might be tempered in the United Nations military forces by mixing the various units together, but certainly not by keeping a Russian unit intact side by side with an intact American unit, with the usual inter-unit competition added to the national spirit of the soldiers in this world enforcement army. But if the military staffs of the U. N. are working out concrete proposals along these lines, for a true internationally minded force, I have yet to read of it.

Similarly, we are plagued in the present world councils over the question of representation. It does not seem fair to some, for example, that each small Latin-American nation should have a vote while much larger nations are also limited to one vote. On the other hand, representation on a population basis may seem unfair to the highly developed states, because surely great masses of ignorant, backward peoples should not carry as much voice in the complicated technology of our world as those with greater experience.

These and a hundred other questions concerning the desirable evolution of the world seem to be getting very little attention. Meanwhile, men high in government propose defence or war measures which would not only compel us to live in a universal atmosphere of fear but would cost untold billions of dollars and ultimately destroy our American free way of life—even before a war.

To retain even a temporary total security in an age of total war, government will have to secure total control. Restrictive measures will be required by the necessities of the situation, not through the conspiracy of wilful men. Starting with the fantastic guardianship now imposed on innocent physics professors, outmoded thinkers will insidiously change men's lives more completely than did Hitler, for the forces behind them will be more compelling.

Before the raid on Hiroshima, leading physicists urged the War Department not to use the bomb against defenceless women and children. The war could have been won without it. The decision was made in consideration of possible future loss of American lives—and now we have to consider possible loss in future atomic bombings of millions of lives. The American decision may have been a fatal error, for men accustom themselves to thinking a weapon which was used once can be used again.

Had we shown other nations the test explosion at Alamogordo, New Mexico, we could have used it as an education for new ideas. It would have been an impressive and favourable moment to make considered proposals for world order to end war. Our renunciation of this weapon as too terrible to use would have carried great weight in negotiations and made convincing our sincerity in asking other nations for a binding partnership to develop these newly unleashed powers for good.

The old type of thinking can raise a thousand objections of 'realism' against this simplicity. But such thought ignores the psychological realities. All men fear atomic war. All men hope for benefits from these new powers. Between the realities of man's true desires and the realities of man's danger, what are the obsolete 'realities' of protocol and military protection?

During the war many persons fell out of the habit of doing their own thinking, for many had to do simply what they were told to do. Today lack of interest would be a great error, for there is much the average man can do about this danger.

This nation held a great debate concerning the menace of the Axis, and again today we need a great chain reaction of awareness and communication. Current proposals should be discussed in the light of the basic facts, in every newspaper, in schools, churches, in town meetings, in private conversations, and neighbour to neighbour. Merely reading about the bomb promotes knowledge in the mind, but only talk between men promotes feelings in the heart.

Not even scientists completely understand atomic energy, for each man's knowledge is incomplete.

Few men have ever seen the bomb. But all men if told a few facts can understand that this bomb and the danger of war is a very real thing, and not something far away. It directly concerns every person in the civilized world. We cannot leave it to generals, senators, and diplomats to work out a solution over a period of generations. Perhaps five years from now several nations will have made bombs and it will be too late to avoid disaster.

Ignoring the realities of faith, good-will and honesty in seeking a solution, we place too much faith in legalisms, treaties, and mechanisms. We must begin through the U. N. Atomic Energy Commission to work for binding agreement, but America's decision will not be made over a table in the United Nations. Our representatives in New York, in Paris, or in Moscow depend ultimately on decisions made in the village square.

To the village square we must carry the facts of atomic energy. From there must come America's voice.

This belief of physicists prompted our formation of the Emergenncy Committee of Atomic Scientists, with headquarters at Princeton, N. J., to make possible a great national campaign for education on these issues. Detailed planning for world security will be easier when negotiators are assured of public understanding of our dilemmas.

Then our American proposals will be not merely documents about machinery, the dull, dry statements of a government to other governments, but the embodiment of a message to humanity from a nation of human beings.

Science has brought forth this danger, but the real problem is in the minds and hearts of men. We will not change the hearts of other men by mechanism, but by changing *our* hearts and speaking bravely.

We must be generous in giving to the world the knowledge we have of the forces of nature, after establishing safeguards against abuse.

We must be not merely willing but actively eager to submit ourselves to binding authority necessary for world security.

We must realize we cannot simultaneously plan for war and peace.

When we are clear in heart and mind—only then shall we find courage to surmount the fear which haunts the world.

ENGINEERING AND INDUSTRIAL DEVELOPMENTS IN RUSSIA

S. K. GHASWALA

BOMBAY

THE Russian Academy of Sciences celebrated its 220th anniversary at Moscow and Leningrad in June, 1945[1]. During that period scientists of many nations were invited to see for themselves the vast technical, and engineering developments of that country. These developments, which have come to light through various Russian technical journals as well as through the impressions gained by some of the responsible engineers who visited that country, are recorded briefly in this article. The present digest mainly deals with the electricity supply industry in Soviet Russia, and the industrial development in the Urals.

ELECTRICITY SUPPLY INDUSTRY[2]

In 1920 the first steps were taken to ensure an organic and homogeneous development for the supply of electricity as part of the first five year plan, according to which agricultural Russia was to be transformed into an agro-industrial State. Since then gradually, the production of electricity soared up, so that at present, Russia produces over 50 milliard kwh of electrical energy as compared with only 1½ milliard kwh in 1918; and consumes about 800 kwh per head per annum. The success of this planning which may well be worthwhile for this country to study, is attributed to the following five main principles.

(*i*) The highest efficiency is obtained by considering the electricity producer and consumer as representing only one unit. Thus the planning of the Dneprostraj power station was carried out together with the planning of the industrial works which were to consume the output of that station.

(*ii*) Emphasis is laid on the utilization of local low grade fuels, and power stations are built directly near such deposits. Thus at Gorki (Nijni Novgorod), the largest peat firing station in the world (204 mw) was built, firing peat of 3,500 kcal/kg and of 25% moisture content.

(*iii*) Efficient power supply should be from a combination of electricity and steam,—a principle adopted by Russia for over 25% of its large stations.

(*iv*) Highest possible use of water power is necessary for industrial economy, as is exemplified in the large water power stations constructed at Volkhov, Svir, and Dnieper, some of which are the biggest of their kind in existence.

(*v*) The creation of a unified high tension transmission system for the whole country.

The electricity supply undertakings are divided in Russia into four groups. The first and the most important groups comprise the large district power stations which account for nearly 75% of the total installed capacity of the country, and are under the jurisdiction of the Ministry of Electricity Supply. The other three groups, accounting for the remaining 25% comprise the municipal stations, under the Ministry for Municipal Affairs, rural stations, under the Ministry for Agriculture and the industrial power stations. Although these four groups are under four different Ministries, the planning for all of them is carried out by a central planning commission. Each supply undertaking, headed by a manager, is given a definite task by the regional managing office, which must be fulfilled under any conditions. This task is usually defined by: definite load curve; maximum permissible cost per unit; maximum fuel consumption per kwh; wages per kwh, and house consumption. These tasks are not definitely fixed but are continuously being checked and revised to ensure the highest level of efficiency in the supply and production of electricity.

Industry in the Urals[3]

Prior to the outbreak of World War II, a good deal of prospecting was carried out in the Chkalov region, which occupies a large part of the Southern Urals and the Caspian lowland. As a result of this, deposits of gold, oil, coal, shale, nickel, copper and iron-ore have been brought to light, and extensive industrial works built up around them. Oil extraction commenced in 1938 near Buguruslan, which now produces oil, eight times its initial volume. A year later the sulphur and copper works at Mednogorsk and the nickel works at Orsk were put into operation. A modern meat-packing plant and an oil-refinery which receives oil from Guryev on the Caspian shore along a 500 mile pipe line has been built in Orsk. The Orskkhalilov iron and steel mills now under construction will use iron-ore discovered near Orsk in 1931. These mills which will produce natural alloys of high grade pig-iron and rolled metal, will consist of four coking batteries, four blast furnaces, seven open hearth furnaces, three bessemer converters, a blooming mill, a powerful rolling mill and a power station. A large reservoir and a 30,000 kw power station are built on the Ural river to feed these mills, which when completed will produce iron and steel in quantities equal to that produced in the whole of the Urals during the Tsarist period.

The Chkalov region is developing into a machine-building centre also. The Kuibyshev plant was built in Buzuluk during this war. This plant will be expanded during the coming 5 years by the addition of a forge shop, foundry and assembly shops. Buzuluk will also receive a new plant for producing machinery for the Ministry of Food Industry. The significance and importance of the region's industry increased during the war. During the last 5 years, 53 new enterprises have been built up which has resulted in an increase in the number of industrial workers by over 200 per cent, while the actual output is some 32 times the 1913 volume of production. Among the other large engineering undertakings, mention may be made of the extension and reconstruction of the Orenburg Railway. New lines are proposed to be built from Sara to Magnitogorsk, and from Chkalov to Ishimbai, en route to Ufa, capital of Bashkiria. Double tracking will be laid on a considerable section of the east of Orsk and the Kuibyshev—Magnitogorsk Railway will cross the Chkalov region which will be converted into one of the most important industrial centres of Soviet Russia. A wide programme of construction of hydro-electric plants is also being contemplated. In fact, even before the war, the power output in the Uzbek Republic was 100 times more than what it was in the pre-revolutionary days. In addition to a large number of small plants, six large installations have been put up, while others are under construction, of which the Forkhad plant now going up on Syr-Darya is one of the largest in U.S.S.R.

General Engineering Developments

Apart from these industrial enterprises the various developments taking place at the several technical institutes in Russia are also highly commendable. Thus the All-Union Thermo-Technical Institute, Moscow, has developed a novel electric system of automatic boiler control which being fully electric requires no special source of energy for its operation.[4] The use of a small electric current further enhances its value. By the employment of mercury contactors it is possible to dispense with the usual relays and solenoid arrangement. The first full-size pneumatic mill has also been designed and put into operation by this Institute.[5] Among the other attainments, the development of a new high-coercive alloy "Magnico", promises to revolutionize the field of electrical engineering appliances, such as magnetos,

electric generators, etc. This new alloy which contains 24 per cent cobalt and is magnetically treated, possesses exceptionally high magnetic qualities, its magnetic energy being 200,000 ergs per cu. cm., *i.e.*, four times that of 'Alnico" (25% Ni, 15% Al), and 22 times that of ordinary 3% chromium steel. Besides this, it has a very high coercive force of 580 Oersted; residual induction of 13,300 Gauss; a relative weight per unit of energy equal to only 1/22 of the Cr-Steel and ¼ of "Alnico"; and an optimum ratio of length to cross section as 3.

The other important problems in the field of engineering and applied science which are being tackled by the Union, are the investigations on the problems of flameless combustion carried out at the Zhukovsky Central Aero-Hydrodynamic Institute, Moscow[7], and the shape of flames near walls[8]; the development of surface hardened tools by high-frequency induction at the Gorki Automobile works[9]; the evolution of experimental methods for determining the frictional torque at the gimbal trunniones of a gyroscope as well as the study of the mechanism of the gyroscope in cardanic suspension[10]; and the study of the complex hydrodynamic theory of heat-exchange and diffusion in turbulent gas flow in pipes.[11]

The outstanding importance of Russian developments is appropriately brought out by the aims of the 5 year programme, laid down in the "Law on the Five-Year Plan, 1946-1950" which was adopted by the Supreme Soviet of the U.S.S.R. on March 18, 1946. According to this official document the aim of the Soviet Union is the ". . . overtaking and outstripping the principal capitalist countries economically, *i.e.*, with respect to the volume of industrial output per head of the population." Russia, with its 180,000,000 people has set the goal for advanced research and development, and the lead taken by her in the various fields of engineering and technology may well form a good example for nations like India to follow.

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SANKAR BALKRISHNA DIXIT :
A GREAT INDIAN SAVANT OF THE LAST CENTURY

R. S. DIXIT*
and
K. R. DIXIT

ROYAL INSTITUTE OF SCIENCE, BOMBAY

IT is an event of a very, very rare occurrence for a mere village primary school teacher to study English, pass the Matriculation Examination and then to pursue the study of astronomy and mathematics after doing his day's duty as a teacher in a school for his livelihood, learn French also in the interest of his study and write an important pioneering work on ancient astronomy, involving valuable historical and astronomical research.

The late Sankar Balkrishna Dixit was such a personage. Born at Murud, a sea-shore village in the district of Ratnagiri in the Province of Bombay in 1853, he was brought up in his poor Brahmin family in a purely village atmosphere for the first 16 years of his life. While studying in the Primary School at

* The senior author is the son of the savant, and resides at 253, Tilakwadi, Poona 2, and the junior author is the grandson, and now senior professor of physics, at the Royal Institute of Science, Bombay. The article has been written at the request of the editors of *Science and Culture*. A short account of S. B. Dixit's Magnum Opum on ancient Indian Astronomy will appear in a later issue of *Science and Culture*.

Murud, he learnt Amarkosh, the great Sanskrit Lexicon, some Sanskrit Kavya, Kaumudi (grammar) and also attained some Vedic lore, then considered necessary in a Brahmin family. On the completion of his primary education at Murud he migrated to Dapoli, a taluka town near his native place and maintained himself by serving as an apprentice in the Civil Court, and learnt a little English during the two years of his stay there. But he soon found that both the things could not go on smoothly as he had to give his whole time to the Civil Court for maintenance. He, therefore, left the place in 1870, went to Poona, appeared for the competitive examination for admission to the Primary Teachers' Training College in which he was successful with a high position. At Poona he underwent a course of three years' training. While studying at the Training College he also attended a private English Class in the morning. On obtaining the highest certificate of the Primary Teachers' Training he

SANKAR BALKRISHNA DIXIT

was appointed Head Master of the full Primary School in the village of Revadanda in Colaba District in 1873. Six years later he was transferred as Head Master of the Primary School at Thana near Bombay where he worked for two years. In 1882 he was transferred to Barsi, a Taluka town in Sholapur District, as an assistant in the Government Middle English School, where he worked till the end of 1889. He was then posted as an assistant in the Government Training School for primary teachers at Dhulia in Khandesh district. He served at Dhulia till 1894 when he was appointed as an assistant in the Government Training College for Primary Teachers at Poona, the very Institution in which he had studied in his early days. He served in this college till his death in April, 1898 at the early age of 45. This is in short the account of his education and government service as a teacher. While in the education department his pay ranged from Rs. 25/- to Rs. 75/- p.m.

As a teacher Mr Dixit's reputation stood high. In the annual report about the progress of the Province of Bombay in Education, during 1989-99, published by the Director of Public Instruction, a special mention about him was made as follows:—"By the death of Mr S. B. Dixit, the Department has lost a hard-working and conscientious teacher."

His methods of teaching were sound and were always adopted with due consideration of the capacity of the students. He often visited the hostels attached to the Training College at Dhulia and at Poona, and at night, especially when the sky was clear, with a view to getting his students acquainted with the stars and planets with the aid of the College Telescope. He never aimed at drilling his students merely from the examination point of view, but always aimed at development of their culture, character and usefulness to the large village public among whom they had to pass their future life. His students still remember the earnest advice he always gave them when they were going out to work as teachers after their examination as to the aims and objects they should place before them while doing their work and as to how they could be serviceable to the public at large.

DIXIT'S PIONEERING WORK

It was, however, as an astronomer, a mathematician and as a pioneer research worker in fixing dates of past events that the late Mr. S. B. Dixit attained reputation not only in Maharashtra but in the whole of India. Had he written his celebrated book, which was his life's work, *viz.*, the *"History of Indian Astronomy"* in English, he would have even obtained world-wide reputation.

In the introduction of this book written in his mother tongue, Marathi, Mr Dixit has stated how he betook himself to the study of astronomy. From his boyhood he had a liking for reading newspapers and had also cultivated a habit of general reading. He also used to write occasionally in the *"Native Opinion"*, a weekly published in Bombay in his days and also in the *"Arunodaya"* of Thana. About 1880 there was a controversy going on in the newspapers published in Maharashtra about the Panchangas or Indian almanacs. These did not take into account

the precession of the equinoxes and predicted things which could not be actually observed in the skies. Mr Dixit's attention was first drawn to this controversy through the newspapers and through it to the study of Indian Astronomy. Naturally he began a close study of old astronomical works and himself being of a critical mind examined each work with minute scrutiny, assessed the real worth of each, paying due attention as to which work was written first and which came afterwards. This naturally infused in him an earnest desire and inclination for the study of the growth and development of Indian Astronomy and the result was the writing of the *"History of Indian Astronomy"* which, as stated above, was his life's work, written merely out of his love of labour and study.

Three Astronomical Works

Mr Dixit wrote in all three books on subjects related to Astronomy, *viz.*, (1) *"Jyotirvilasa"* or as it is popularly called "Entertainment for two Ghatikas or three quarters of an hour at night", (2) *"History of Indian Astronomy"* and (3) *"The Indian Calendar"*. A summary of what is contained in these books is given below.

(1) *"Jyotirvilasa"* is a popular book on astronomy written mainly for the general reader. It is just like Jeans' popular works on heavenly bodies. The language of the book is so charming and attractive that extracts from the book or even some occasional chapters are often given in school readers in Marathi language, with a view to placing before the young pupils samples of good language. The University of Bombay also prescribes this book frequently as a text-book in the Marathi language. This book is translated in other Indian languages and is being revised at present by the authors of this article with a view to bringing the information up to date.

(2) *The Bharatiya Jyotis-Shastra* or the 'History of Indian Astronomy' traces the development and growth of astronomy in India from the Vedic period down to the author's time in 525 pages of demi-octavo size in Marathi. To achieve this objective, Mr Dixit had to read critically over a thousand books including *the Vedas, the Brahmanas, the Upanishads,* and other books in English and French. Hundreds of quotations from the Vedas and other Sanskrit works are cited in this book to prove the statements made and Mr Dixit says in the preface that he has given only such quotations and made such statements as were verified by him and that he has not relied on secondhand references. As occasion arose he calculated the time or the date when a particular work was written, and has also stated that mathematical calculations required in the book have been made by him. Being thus an epoch-making work, historically important from the point of view of original research, a summary of its contents will be given in separate articles.

(3) *The Indian Calendar.*—This book with its elaborate and numerous chronological tables was written in 1896 by Mr S. B. Dixit and Mr Robert Sewell, I.C.S. European and Indian Scholars engaged in antiquarian research found it very difficult to convert Hindu and Muhammedan dates occurring in Inscriptions, Copper Plates, Sanads, etc. into A.D. dates and *vice versa.* It was, therefore, mainly designed for the use of those engaged in the decipherment of Indian Inscriptions and compilation of Indian History. Incidentally it can be successfully used in Courts of Justice and Government Offices in India, since documents bearing dates prior to those given in any of the existing printed almanacs, are often produced as evidence of title and by making use of the Tables given in *"The Indian Calendar"* the Courts and Government Offices had at hand ready means for verifying the authenticity of the dates given in these documents. As the authors say in the first paragraph, their chief objects in publishing the big volume are mainly three:—first, to provide simple methods for converting any Indian date—Luni-Solar or Solar—falling between the years A.D. 300 and A.D. 1900 into its equivalent A.D. date and *vice versa* and for finding the week day corresponding to any such date; secondly, to enable a speedy calculation to be made for the determination of the remaining three of the five principal elements or Angas of an Indian Panchanga, namely the Nakshatra, Yoga and Karan at any moment of any given date during the above period of 1600 years, and thirdly to provide an easy process for the verification of Indian dates falling in the above period. With a view to enabling even an ordinary person to make a correct use of the Tables given in the Volume, the nature of the Indian Calendar together with its contents is amply and carefully explained in Part I of the book. Detailed accounts of the various Eras, namely, the Vikrama Era, Saka Era, the Bengali Era, the Gupta Era, the Kollum or Parashuram Era and other Eras are given in Part II mentioning the various provinces in which these are followed. Parts III and IV give a very detailed description and explanation of all the tables showing the way in which these are to be used with numerous examples of conversion of any date in any Indian Era into its A.D. equivalent and *vice versa.* In Part V detailed information about the Muhammedan Calendar is also given. Out of the 16 tables given in this book table I, extending over a hundred pages, is the principal one. The data in this table forms the basis of all calculations to be made for conversion of dates. The concurrent years of the principal eras and the names of their Samvatsaras are given

in the first eight columns. The next five columns give names of added or Adhika Lunar months for the years when these occur, with the time of the preceding Sankranti and that of the succeeding Sankranti, expressed in Lunation Parts and Tithis. Similar information about suppressed or Kshaya months is also given, whenever they occur at intervals. Then follow eleven columns giving details about the commencement of both the solar and luni-solar years, namely the Gregorian date and the name of the day of the week when the new year commenced, with its time not only in *Ghatis* and *Palas* but also in hours and minutes, the Moon's age in Lunation Parts and Tithi elapsed. It is the figures and dates given in the last eight columns which particularly enable us to convert and verify Indian luni-solar dates. The figure-work in these columns was arrived at by Mr S. B. Dixit by making elaborate calculations direct from Surya-Siddhanta. At the end of the Book is an Appendix with the necessary Tables extending over 40 pages prepared by Dr Robert Schram, which makes it easy for any one to ascertain the incidence, in time and place, of every Solar Eclipse occurring in India from A.D. 300 to A.D. 1000.

Mr Dixit wrote occasionally in the *Indian Antiquary* articles on astronomical topics. He also readily helped other European and Indian scholars in matters of determination of ancient dates, and particularly Dr J. F. Fleet and Mr R. Sewell (members of the I.C.S.). In his obituary note, written by Dr Fleet in the *Indian Antiquary* after Mr Dixit's death (*Ind. Ant.*, 27, 1898, p. 194) he has gratefully acknowledged the help rendered while he was preparing his great Volume on the Gupta Inscriptions and says that but for Mr Dixit's help the much-vexed question of certain dates in the Gupta Era would never have been exactly and finally settled. In the same note Dr Fleet states further that it was a real pleasure to seek his aid because he had always in view the extension of knowledge and genuine desire to remove the difficulties of others and had no concern with finding fault with the works done by others for personal exaltation.

Mr Dixit also wrote two other important works outside the sphere of astronomy. The first of these is on the geography of ancient India (from the beginning of the Vedic period up to 1000 A.D.), while the second is a translation or rather an adaptation of Max-Müller's four important lectures on religion, called Dharma-Mimansa (An inquiry into religion). Mr Dixit also wrote some other books relating to his profession as a teacher. These were '*The theory and principles of the different topics in Arithmetic*', '*Physical Geography*', '*Essays on Grammar*'.

The chief ambition of his life was, as he has himself stated in his history of astronomy, to write a *Karan* work or rather a *Siddhantic* work by the help of which a Panchanga, which would be quite free from any error and would tally with what was actually observed in the sky, could be prepared. But the cruel hand of death cut short the span of his life at the early age of forty-five.

In the end, the writers of this article would like to state that they are not astronomers and it may be that errors have crept in. They, however, felt that Mr Dixit's book, 'History of Indian Astronomy' should be translated in English. Unfortunately no competent person came forward to do this during the last fifty years that have elapsed since the publication of the book. Consequently Mr Dixit's great work probably remains unknown to many. The writers as well as the Editors of 'SCIENCE AND CULTURE' *thought it desirable to write an introductory article like the present one. They hope and trust that a competent person would soon come forward and translate in English the monumental work of the late Mr S. B. Dixit.*

U. S. BUREAU OF MINES AND ITS WAR-TIME PILOT PLANTS

G. C. MITTER,

MINT, BOMBAY

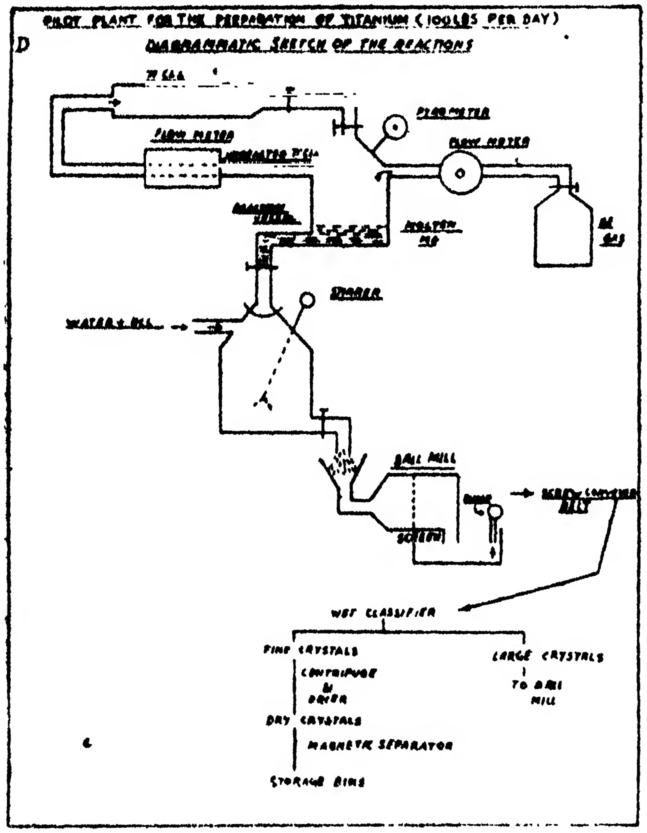
(Continued from the last issue)

PILOT PLANT FOR THE PREPARATION OF TITANIUM

(100 LBS. PER DAY)

Procedure.—Commercial $TiCl_4$ is first purified by fractional distillation from (1) water which remains in the boiler and (2) silicon tetrachloride which collects in one bulb of the fractionating column. It is then led through pipe into a reaction chamber which is actually a cylindrical furnace having a mild steel inner body with an outer shell of refractory bricks and heated to 800°C. by oil burners. At the bottom of the reaction chamber is a mass of molten magnesium, the atmosphere of the chamber being of helium gas. The reaction is exothermic and yields a product of metallic titanium, magnesium chloride and leaves behind some unacted magnesium metal. The completion of the reaction is marked by a fall in temperature to 45°C. at the

neck of the reaction vessel which is the normal temperature. The reaction products are emptied into a reservoir where they are acted upon by water and dilute hydrochloric acid dissolving magnesium chloride. The titanium metal is ground wet in a ball mill fitted with a screen and the product goes up a drag type of wet classifier which has an inclined screw type conveyer belt. A stream of water carries down the finer particles to a centrifuge, while the heavier ones are pushed up along the belt and are finally discharged at the upper end to a bin whence they are returned to the ball mill. From the centrifuge, the crystals pass through a drier and a magnetic separator, finally collecting in the storage bin.



The production has been developed to the stage of yielding in batches 15 lb. of high purity titanium powder. The product is slightly contaminated with hydrogen and magnesium. Both these impurities are removed by sintering in a high vacuum at 1000°C. These compacts are ductile and can be made into sheets and bars by normal methods. The worker in the field is Dr R. S. Dean of the Bureau and his collaborators.

CHROMIUM FROM LOW GRADE CHROMITE (39·0% Cr_2O_3)

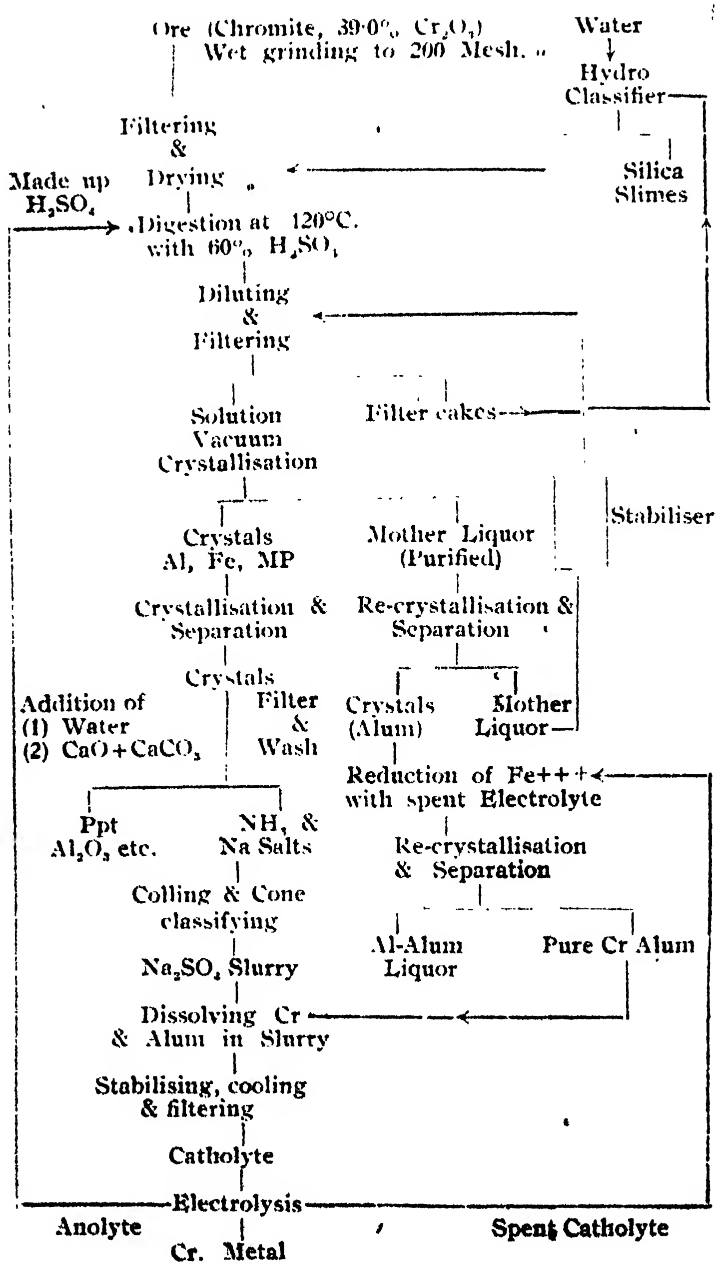
The process outlined below is the result of a number of experiments undertaken by Lloyd and his workers in the Boulder City field station of the Bureau to effect electrowinning of chromium from trivalent salt solutions.

The efficiency of the method is due to the success of obtaining a purified chromium ammonium alum as the cell feed.

The most important variables are divalent chromium concentration; sulphide addition; purity of electrolyte; pH; temperature; current density and the concentration of chromium, sodium and ammonium salts. The effect of most of these variables are interrelated and any one variable may be changed if others are adjusted accordingly.

The cell operating data of the pilot plant are as follows:

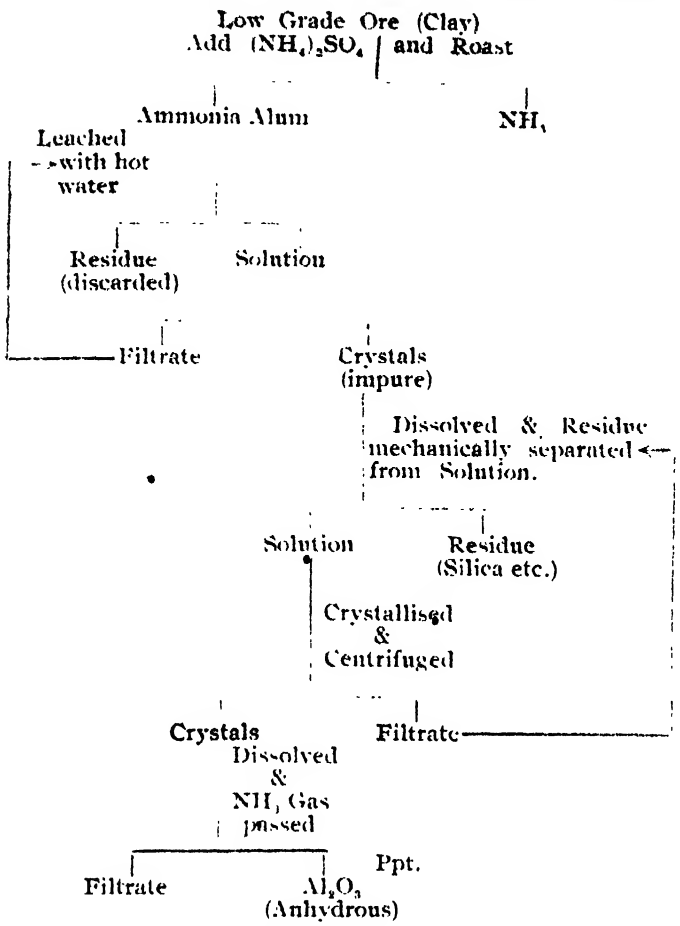
Cathode	.	Aluminium 10 sq. ft.
Deposition time	...	48 hours.
Metal deposition		21·6 lb.
Current efficiency	...	45%.
Cell potential	...	4·6 volts.
KW-hr/lb. of metal	..	7·2.
Cathode current density		68 amp./sq. ft.
pH	..	1·86.
Sulphite addition	.	0·7 c.c. of .1N/L/hour.
Temperature		32·3°C.



Pilot Plant for the Manufacture of Alumina from Low Grade Al. Ore

A. *From Clay.*

(Field Station, Salt Lake City, U. S. Bureau of Mines).



Diagrammatic Sketch of the Process.

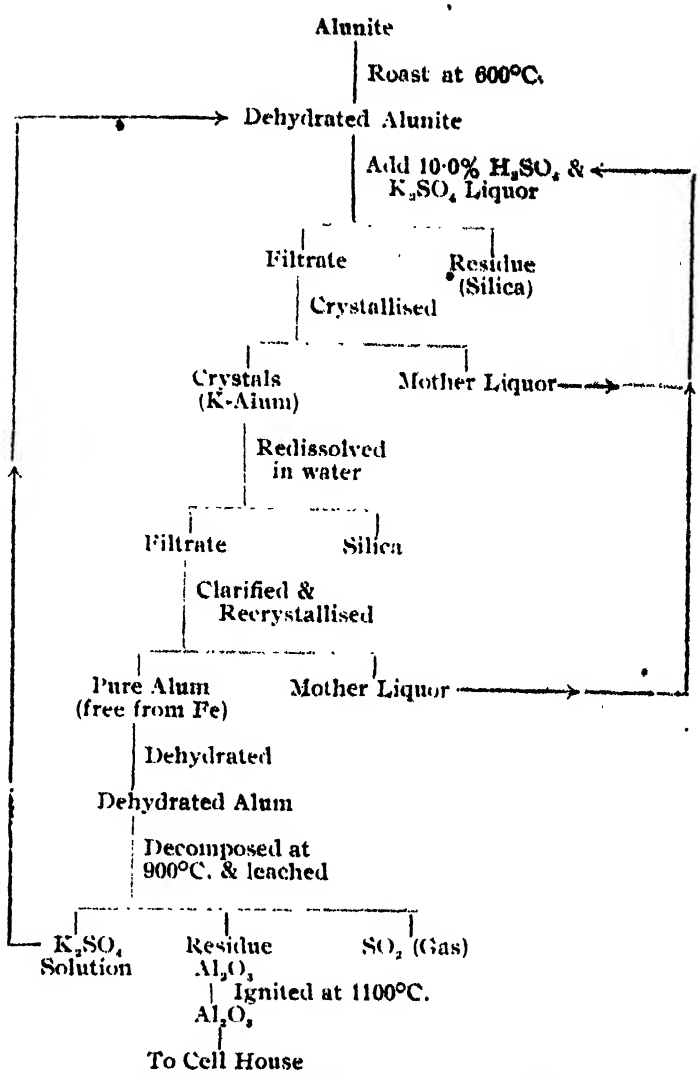
Clay having 21 per cent of available alumina is thoroughly mixed with requisite quantity of ammonium sulphate so as to form a thick viscous mass. The charge is fed from the top into a vertical roasting furnace, cylindrical in shape. The furnace is heated by gas burners fitted to the side walls in such a way that the flame does not come in direct contact with the charge. A temperature of 390-400°C. is maintained. The products of the reaction are ammonia alum and ammonia gas. The alumina content of the former is now 13%. The alum is easily liquated with hot water from the roasted mass and the ammonia gas can either be passed into the purified ammonia alum to yield alumina and ammonium sulphate or it is led through pipes into condensing and absorbing towers, finally passing out of scrubbers into the air. The ammoniacal solution thus obtained is fixed with dilute sulphuric acid forming ammonium sulphate which is recycled.

The purification of the liquated ammonia alum is effected thus :

The leached solution is crystallised by cooling. The impure crystals (containing silica and unreacted clay) are dissolved and directed to flow into a hopper and then drops downward along a chute to which is fitted an inclined screw conveyer. The function of the conveyer is to move the residual solid matter up the incline, while allowing the watery extract of ammonia alum to flow into a reservoir. From the reservoir the solution flows into crystallising pans and alum crystallised out. The crystals are centrifuged and dissolved in water again. Ammonia gas, product of the roasting chamber, is passed into this solution when alum is precipitated in a highly purified condition.

B. *Alumina from Alunite* K_2SO_4, $Al_2(SO_4)_3$, $2Al_2O_3$, $6H_2O$.

(Field Station, Boulder City, U. S. Bureau of Mines)



Diagrammatic Sketch of the Process.

Procedure.—Mineral alunite is roasted in a rotary kiln, horizontal in shape at a temperature of 600°C. when it loses its water of crystallisation. To the dehydrated product dilute sulphuric acid (10%) and potassium sulphate, obtained from later operation are added so as to form normal potash alum (K_2SO_4, $Al_2(SO_4)_3$, $24H_2O$); silica is thrown out. After the separation of silica by decantation, the alum solution is crystallised, mother liquor being used up in the treatment of the roasted mineral. The crude crystals are redissolved, clarified and recrystallised when pure alum free from iron is obtained. The pure alum crystals are dehydrated in a vertical columnar furnace heated from sides by burners. The dehydrated crystals are conveyed mechanically into the decomposition chamber where under a constant decompositing temperature of 900°C. the alum is decomposed into K_2SO_4, Al_2O_3 and SO_2. On leaching potassium sulphate goes into solution leaving Al_2O_3 as residue. The alumina so obtained is ignited at 1100°C. and then it is ready to go to the cell house for electrolysis.

INDUSTRIAL USES OF FATS

B. DASS
PROFESSOR OF APPLIED CHEMISTRY
and
KAMALENDU SEN-GUPTA
LECTURER IN CHEMISTRY, CHEMICAL ENGINEERING DEPT.,
COLLEGE OF ENGINEERING & TECHNOLOGY, BENGAL (JADABPUR)

SOURCES AND DEMANDS OF FATS

INDIA is a huge producer of fat-bearing materials both in quantity and variety. Agriculture is the main industry of India in which more than 80% of the people of the country are employed. More than ten million tons of fat-bearing seeds numbering more than 500 in variety are obtained from Indian agriculture and forests. This quantity of production can be considerably increased by suitable planning and modernization of agriculture and tapping the sources of supply which have not hitherto been properly done on a planned basis. India with her far flung coast lines on the east and the west, contains innumerable rivers, lakes, tributaries, canals, streams of various kinds, large and small. All these sources are rich in marine animals from which animal fats in huge quantities can be obtained. Up till now this enormous source of fats of considerable potentiality is practically untapped. India's domestic animal stock is the largest in the world, United States of America being a bad second to India. This source at present yields more than 2½ crore maunds of ghee and butter worth over rupees 500 crores.

The fat recovery industry yields cakes, meals, etc., rich in protein and perfectly suitable for manuring purposes for Indian agriculture and for use as cattle food for India's huge animal stock. Hence it would be clear that the future economic development of India is bound up directly or indirectly with the development of fat-industry of the country.

Development of this important basic industry of India along modern lines has been rather slow. However, recently and specially during the last war a beginning has been made which is indeed capable of expansion and of improvements in future. This development has been considerably influenced and accelerated by the advent of fat-hydrogenation industry which is capable of producing many more useful products both edible and non-edible. India holds the monopoly of certain varieties of very useful fat-bearing materials, such as castor seeds, neem seeds, mahua seeds and nuts of many kinds, such as cashew nuts, bhilawan (bhela or marking) nuts, etc.

There are at present in India about 20 fat hydrogenation plants scattered all over the country. These plants produce daily about 500 tons of vegetable ghee and a small quantity of vegetable tallow. This quantity hardly meets even a fraction of the demand for vegetable ghee. Government of India has sanctioned about 30 more plants for hydrogenation of fats to produce vegetable ghee and vegetable tallow. According to the present plan, erection of these plants must be completed and production started by the end of this year. Some of these plants are expected to manufacture vegetable tallow for soap making. In view of the heavy demand for both vegetable ghee and vegetable tallow, present and prospective, more fat hydrogenation plants must be installed in future to meet the future demand. With the advent of new uses of fats for various industries, an account of which is given in this ariticle, fat production of the country will also as a matter of necessity be considerably increased.

It is indeed sad and painful that in spite of such huge sources of supply of fat-bearing materials, the people of the country should suffer from fat deficiency, and the agriculture of the country should suffer for want of manure. The Hon'ble Dr Rajendra Prasad, the present Food Member of the Interim Government, has rightly said that fat production of the country will have to be increased 2⅓ times in order to meet the bare necessity for fat required for health. The recent pitiable plight in the matter of supply of mustard oil in Calcutta and outside Bengal should be an eye-opener to the capitalists of Bengal particularly and to the Indian capitalists in general. There has been a rapid drive during the war in the manufacture of soaps of all kinds, *viz.*, toilet, washing and industrial. Some very modern soap plants are in the process of construction in the country investing crores of rupees as capital. The general public are using more soaps now than before and there are indications of improvements in taste and hygienic habits. Hence many more such plants will have to be erected to meet the minimum requirement of the four hundred million people of the country. This development is also bringing about the development of certain branches of basic chemical industry such as caustic soda, bleaching powder, etc. It would be impossible to meet the enormous demands for fats in near future for edible and other

purposes from raw materials obtained solely from agriculture and forests. Hence we must tap the marine resources of the country to produce the additional quantity of fat. It is claimed that Bay of Bengal is richest in marine animals from which animal fats can be easily recovered. A well organized scheme backed by sufficient capital to exploit the marine resources is worth attraction immediately.

Uses of Fats

It will be of interest to all concerned to know the various industrial uses to which fats of different kinds are employed in modern industries in order to visualize the future possibilities of the fat industry for this country.

About 50 per cent fats produced are used for human consumption and the balance for industrial purposes.

Soaps besides being used for toileting and washing purposes are also used as industrial soaps or metallic soaps. Metallic soaps have not only medicinal uses but they also enter into the manufacture of rubber, lubricants for wire drawing, insecticides, etc., and for applying metallic colour to ceramic wares, for desulphurizing gasoline and other purposes.

It will not be out of place to mention here that glycerine which is obtained as bye-product in the manufacture of soap is extensively used in medicinal, explosive and other industries.

Fats used for various industrial purposes are as follows:

Fats	*Uses*
(a) Tallow, cocoanut, palm, fish, palm-kernel, cottonseed, soyabean, mahaa, olive, bone-fat, etc.	Soaps.
(b) Linseed, tung, castor, perilla, fish, soyabean, etc.	Paints and varnishes.
(c) Linseed, tung, castor, perilla, fish, soyabean, cottonseed, etc.	Oil cloth and linoleum.
(d) Linseed, tung, castor, perilla, fish, etc.	Printing ink.
(e) Soyabean meal (in a phenol-formaldehyde adhesive), cottonseed, etc.	Water proofing.
(f) Fatty acids obtained from fats instead of phthalic anhydride (with glycerol), etc.	Synthetic resins.

The coating industry includes the manufacture of paint, varnish, oil cloth, linoleum, printing ink, water proofing, synthetic resins, lacquer, enamel, insulations, etc.

The paper industry is experimenting with the use of edible fats, especially with hydrogenated fats, for some of its coating problem to supplement paraffin wax.

Rubber industry is using stearic acid obtained from fats. Rubber substitutes are being produced from vegetable fats by reaction with sulphur chloride to form the well known Artgum. Rape seed oil, soyabean oil and corn oil are preferred for this purpose.

Textile industry is using sulphonated fats, *e.g.*, sulphonated castor oil ("Turkey red oil").

Tin and tin plate industry is using palm oil. The plated sheets are pulled from the tin bath through a layer of molten oil to protect them from oxidation and to remove oxides of tin.

Castor oil, cod liver oil, almond oil and *chaulmoogra* oil are used medicinally. Liquid fats are used in canvas coverings, in tanning and finishing leather and in the dying of certain textiles ("Turkey red oil"). Stearic acid obtained from fats and tallow are used in crayons and marking pencil. Castor oil is used in hydraulic brake fluids. Castor oil, cotton seed oil, lard oil and neat's foot oil are used as lubricator in internal combustion engines and other machineries. As liquid oil film lubricator for delicate machineries, castor oil is used; as solid lubricator, blended oils are used and as viscous lubricator for coarse machineries and bearings, hardened fats and emulsified oils are used. It is sure that castor oil will play an important role in the near future as lubricator as it possesses the best lubricating film. It forms the major part in the composition of the lubricator used in aeroplanes. Stearic acid obtained from fats is used in the manufacture of candles. Lard oil is used as illuminant, in metal cutting, etc.

Though lighting by fats has been displaced by gas, electricity and kerosine, yet in remote villages this is not yet obsolete.

Considerable use of fats as fuel and lubricator is bound to take place in India with the development of her industries, due to the shortage of petroleum resources. Fats as such are good substitutes of crude oil but not of petrol. However, new methods are being developed to convert fats to alcohols and hydrocarbons to be used in the place of petrol or gasoline. Hence fats, *e.g.*, groundnut, cotton, coconuts, poppyseed oil, etc., are not only used in Diesel engines but may be used also in petrol engines. Compared with mineral oils, vegetable oils are less inflammable and hence may be safely trans-

ported from one place to another or may be safely stored to be used as fuel in aeroplanes or ships. As alcohol may be produced from *mahua* flowers and oils can be produced from its seeds, Mahua plants alone can give us fuels for both petrol engines and Diesel engines. There are huge mahua forests in different parts of the country.

New Process of Refining

It is the triumph of chemists to find out very recently a new method which is expected to completely displace the old method of refining oils by alkali treatment. It is now claimed that soyabean and linseed oils are much more improved in quality by catalytic conjugation without decomposition, than by alkali refining. These conjugated oils are now-a-days used in many industries. The advantages of these oils are that (*a*) these oils can be bodied to the same viscosity as in the case of alkali refined oils but without the substantial loss of the oil and increase in acid value that occurs with the latter, (*b*) the bodying can be achieved in much less time, (*c*) paints made with these oils "set" to the touch two or three times as fast as those made with alkali refined oils, and (*d*) these oils are more suitable for use in primer coats because these do not penetrate porous surfaces as rapidly or to such a large extent as in case of refined oils.

If in a higher fatty acid or a glyceride of the fatty acid of an unsaturated type, the two or more "CH" groups can be joined together consecutively by means of double bonds, the acid or the glyceride is said to have been conjugated. This is nothing but isomerization. The drying property of a fat increases with its unsaturated fatty acid content but its drying property tends to increase more so if the unsaturated fatty acids are conjugated. In fact, the higher the conjugation, the higher would be its drying property. The highest drying property is of tung oil, then comes linseed and last of all comes the soyabean oil. Now if by some process, the fatty acids of the linseed and soyabean oils can be converted into their conjugated forms, their drying properties would be increased and these then can be used to substitute tung oil.

Due to the shortage of drying oils during the last war, experiments were undertaken to develop an economical process for the isomerization of non-conjugated oils such as the drying oils and semi-drying oils to conjugated forms with a view to increasing their drying properties. These experiments have been successful and the drying property of soyabean oil which is a semi-drying oil has been considerably increased. The composition of the oils containing unsaturated fatty acids, their iodine numbers and also a brief description of the process of conjugation of soyabean oil is given below:

Oils	Unsaturated acids				Iodine values
	Oleic $C_{18}H_{34}O_2$	Linoleic $C_{18}H_{32}O_2$	Linolenic $C_{18}H_{30}O_2$	Elaeostearic $C_{18}H_{30}O_2$	
Tung oil	4·1	0·6	...	90·7	160-180
Linseed oil	18·8	24·2	47·3	...	170-185
Soyabean oil	28·9	50·7	65	...	124-133

Process of Conjugation of Soyabean Oil

Soyabean oil to be conjugated is passed through a process of preliminary refining. The refined soyabean oil is mixed with activated nickel catalyst. The amount of catalyst used is 6 per cent on the weight of oil. The mixture is now heated to a temperature of 170°C for 6 hours. Upon this the oil is claimed to be conjugated and its drying property is considerably increased. After cooling, the oil is filtered through a filter press and is then stored for use.

The process of making the nickel catalyst for conjugation of oil is as follows.

Nickel nitrate deposited on activated carbon is followed by treatment with ammonium carbonate—the catalyst composition thus formed is activated by heating at 360°C for two hours in an atmosphere of hydrogen.

The catalyst can be reactivated for using it over again, in the process.

Isomerization has just begun to be used commercially and its economic position has not yet been fully established. However, isomerization has been used successfully to increase the drying property of soyabean oil as described above. Naturally commercial possibility of this process is certainly bright.

With the increasing demand for drying oils needed in the manufacture of surface coverings of innumerable varieties, the existing source of supply of drying oils seems to be inadequate. Hence to increase the drying property of drying oils and of the semi-drying oils is of great practical importance and isomerization seems to have solved this problem. Naturally large quantities of oils of different kinds hitherto not used as drying oils will be available for use as drying oils to meet the future demands of the industries.

Hydrogenation has solved the problem of converting unsaturated fats to saturated forms as a result of which large quantities of cheap fats are being converted to hard fats or tallow economically by

hydrogenation to meet the demand of the industries manufacturing edible fats, soaps, etc. So isomerization is expected to play as important a part in increasing the usefulness of fats as hydrogenation has already done.

It will not be out of place to give below some statistical figures showing the development of fat technology (manufacture of oils and fats ; paints and varnishes . and soaps) in the U.S.A., the greatest industrially-developed country in the world.

Industries	No. of plants	No. of wage earners	Value of products
1. Petroleum products ..	485	72,840	$2,461,126,549
2. Oil Products :			
(*i*) oils & fats ..	1,261	33,680	630,863,141
(*ii*) paints & varnishes	1,255	28,173	518,846,737
(*iii*) soaps	901	18,752	392,401,226
Total	3,417	80,605	1,542,111,104
3. Paper and Pulp ..	832	137,445	1,159,867,486
4. Chemicals	2,766	83,130	1,137,490,299
5. Glass & Ceramics ..	1,859	129,946	554,005,611
6. Drugs, medicines, cosmetics	1,633	32,749	512,450,989
7. Leather	446	47,252	346,437,554
8. Lime & Cement ..	429	33,259	229,582,475
9. Fertilizers	761	18,744	185,684,328

From the above statistics it will be clear that oil products such as oils and fats, paints and varnishes and soaps occupy the second place in the value of the products and fourth place in the number of men employed and possess the largest number of plants.

The manufacture of fats from vegetable sources is increasing in quantity and is making use of some up-to-date equipments for recovery processes in this country. The manufacturo of animal fats (marine fats), paints and varnishes and other surface coverings is just beginning and the progress is very slow. The production of soaps is increasing with leaps and bounds and a number of plants with most up-to-date equipments for the manufacture of soaps of good quality have been erected and also are being erected. The quality of toilet soaps produced in the soap plants is as good as the imported soaps of best quality, if not better. Late Sir P. C. Ray often said that soaps rather than imported in India should be exported from India. From the progress already made in the manufacture of soaps of quality it will not be unreasonable to think that Sir P. C. Ray's wishes may be fulfilled.

Then again the total population of India is four times that of the U.S.A. The standard living of the people of this country is also continuously rising. India's resources of fat-bearing materials of all kinds are the largest in the world. So it is not necessary to emphasize the possibility of the growth of the technology of fats in this country in the near future. All the different industries mentioned in the above list are gradually and steadily growing in India and it can be reasonably said that the oil-products-industry is sure to occupy a higher place in the list of technological industries than in the U.S.A.

STORAGE OF RICE

M. R. PANIKKAR
NEW DELHI

Introduction

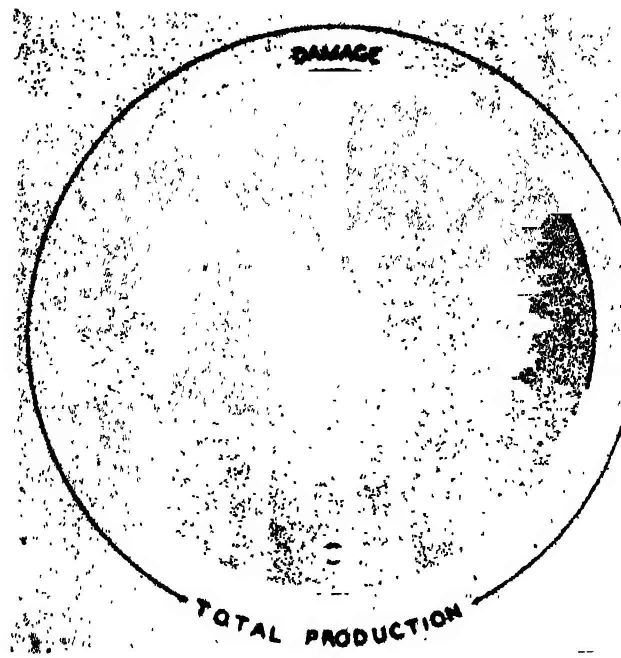
Careful storage of a commodity is next in importance to its production, as whatever energy and expenses spent on the latter runs to waste if it is not properly and economically stored and conserved. This is much more true of agricultural commodities which by their very nature require careful storage. For a predominantly agricultural country like India where diminishing return from the land is more a matter of course rather than one of accident, with increasing population to feed every year, the problem of storage of its agricultural commodities is a matter of prime importance. Rice is more subject to deterioration and destruction than other cereals and about 1·5% of annual crop of rice is lost during storage. This important cereal food of the country is mainly grown under swampy conditions in warm and moist climates, where necessarily it has to be stored. The cumulative effect of the unfavourable climatic environmental complex expressed in the shape of dampness, rancidity, loss of nutritive factors, pest attack and other deleterious influences on storage of rice is a serious problem to India, as rice is the main staple food of the population, and even the existing production is hardly sufficient to feed the people. As a preventive against the loss in storage, change of location of stores is manifestly impossible, as also the method of storing rice, since the crop by its very nature requires ripening in storage before it could be consumed.

Necessity for Storage

Matured rice.—Rice husked immediately after harvest gives higher percentage of broken grains and the product tends to cook rapidly into a mushy glutinous mass, giving lesser volume of cooked rice, which is not wholesome for consumption. Some varieties like G. E. B. 24, etc. become ready for use much sooner than others. But the average rice to be fit for consumption should either be parboiled or stored for some time, the period of storage depending upon the variety. Before use, cheap and medium types of rices are stored for minimum period of 3 months. Rice stored in air-tight containers become fit for consumption much sooner than those stored in places where there is free access of air. Rice stored in pits, as is done in Ganjam and Nellore, for about two months get the same cooking qualities as of one year old grains. Well stored rice takes longer time to cook absorbing more water; the grains elongate and retain their individuality and swell to four times their original volume and do not dry hard if kept long and the food is more easily digestible.

Rice stock.—Paddy stocks held for trade purposes vary in different areas depending upon the seasonal arrival of the crop. In Bengal, United Provinces and Bihar the crop accumulates from January to March; in Orissa, February to April; in Madras, February to April and September; in Sind, November to December; and in the Punjab, October to December. In the case of husked rice the stocks are normally larger between March and June. Holding back the stock as is done in other agricultural commodities to influence post-harvest prices does not seem to be popular in the case of rice. In some areas there are sufficient inducements to growers to hold back stock till the post-harvest depression is over so that the higher seasonal rise in prices may fetch a greater profit. Yet the general tendency, especially among growers, who are the prime factors in the trade, is not for storing, but to sell the stock and clear the accumulated pre-harvest encumbrances.

Old rice.—Paddy and rice, usually of the finer varieties, are held in long storage with the express object of getting more premium from discriminating consumers. Optimum length of storage of such well matured rices depends upon so many variables like consumer's preference, his methods of preparation and the variety of the rice stored. Trade has its own standards for old qualities of rice. In the United Provinces three years is the optimum period for fine rice, while 1 to 1½ years of storing is generally considered as sufficient for coarse and medium types of rice. In the Punjab 2 to 3 years must elapse before the fine-scented rice is considered to be the best, while 1 to 1½ years is sufficient for the high grade *Sugdasi* variety. High prices are normally obtained for these well matured old rice; in India, generally speaking premium of 12 to 20 per cent are given for one-year old fine rice, and 5 to 10 per cent for other varieties compared with the new crop.



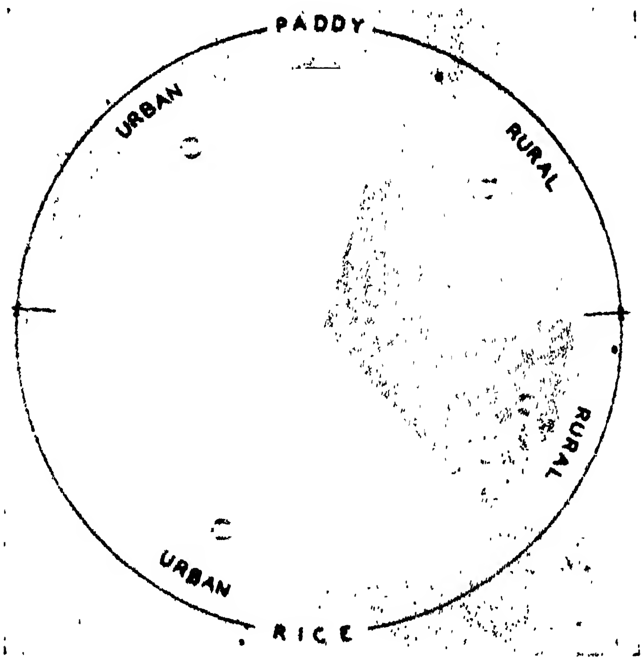
ANNUAL PROPORTIONATE DAMAGE TO RICE PRODUCTION (shown in circles by difference in shade).

Seed.—Storing for the purpose of seed is an unavoidable necessity. About 6 per cent of the crop or about 2½ million tons of paddy on an average is annually kept solely for seed purposes. They are generally kept in straw packages in Madras, Bombay, Central Provinces, Orissa and Assam; in mud vessels In Bengal, United Provinces and the Punjab; and in gunny bags in Sind. Marutheru Expts. quoted by Ramiah[1] showed that the crop harvested and dried in hot May and kept in metallic bins is the best for seed, while that stored in gunny bags with an occasional drying is the second best.

Locality of Stores and Storing

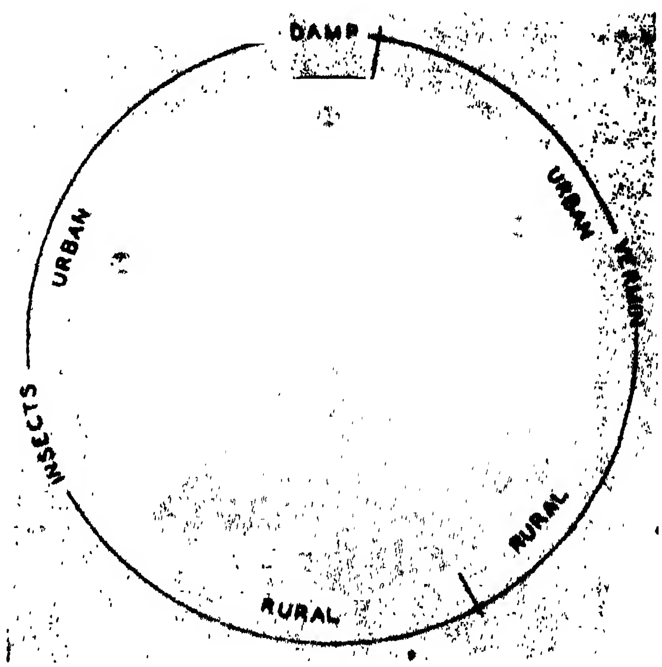
Storage location and accommodation in India are much varied, elastic and complex. It is not localized in special areas nor confined to special structures meant exclusively for the purposes, as in the more advanced agricultural countries; any covered or uncovered space, from a hovel which combines the *Ryot's* house and cow-shed to the lumber room or basement of the trader is pressed into service, as occasion arises. This unorganized and unhygienic system of storage dispersed over wide areas entails heavy expenditure in handling and transport, losses by leakages, deterioration of containers due to multiple handling, etc. in addition to the primary losses engendered by damp and pests.

State of crop.—The state of the crop to be stored whether husked or not, is an important factor in the matter of location of stores and the receptacles for storing. Barring those exclusively kept for seed purposes, the rice produce is kept during a part of the storage period as paddy and then as rice, the quantities stored and the duration of storage varying with the local conditions and the purposes for which they are kept.



DAMAGE IN PADDY AND RICE (shown separately).

Rice in husk.—Rice in husk suffers comparatively lesser damage and deterioration in stores than husked rice on account of the protection of the husk. In Kashmir, Assam, parts of Bombay and the Peninsular India, where it has been proved that husked rices do not keep long, and where the same premium, as for old rice, is paid for rice from old paddy, unhusked rice is kept for maturing. The bulk of rice held in rural areas is in unhusked form and is stored mainly in home-made receptacles either made of straw like the *Pattarais* in Madras, *Morais* in Bengal, *Kacherias* in Bihar, *Lotuas* in Central Provinces, *Moodaes* in Mysore, etc., or made of bamboo splits like the *Golas* in Bengal, *Bherias* in Bihar, *Dholas* in Central Provinces, *Kanajas* in Bombay, *Pallis* in Sind, etc., or made of stalks of cotton or other crops like *Kangni* in Hyderabad or *Kalanjan* or Palm ribs like the *Gadi* in Madras. They may also be semi-permanent mud and brick structures like the *Kothis* in United Provinces, Central Provinces and Bihar, *Gundis* in Sind, *Panats* in Konkan and Assam, *Kothas* in North India, *Kanajas* in Mysore, etc., the durability, capacity, shape and the nature of construction varying with custom, convenience, and necessity. Paddy is stored in wooden structures of various sizes and shapes in Kerala, Mysore, Bombay and Kashmir, while in parts of Madras, South Orissa and Bihar pit storage is practised. About half the marketable surplus of rice crop is moved into the markets during the first four months of the crop year and kept mostly in cement or stone floored godowns. In Bengal, Central Provinces and the Punjab, rice is stored in bulk and in bags ; in the United Provinces in small masonry *Kothas* ; in Madras in cylindrical bamboo *Gadi* or wooden box-like *Dhanyappa kottu* of 500 to 700 maunds capacity ; and in Kashmir in large cylindrical wooden granaries. In big Mills, special *pucca* godowns are available, while comparatively little paddy is stored long at the various Indian Ports, where ample though costly facilities for storage exist. On the whole, urban areas are comparatively well off than rural areas in storage convenience.



SHARE OF PESTS AND DAMAGING AGENTS.

Husked rice.—The common practice in the main rice growing areas is to store paddy in bulk and rice in bags, since the latter moves constantly in the channels of distribution. In the Punjab and Sind husked rice is as a rule kept in bulk heaps. But the general practice in Central Provinces, United Provinces and other Upper Indian areas is to store husked rice for general trade purposes and for ageing a year or more in closed receptacles. In Calcutta, preservatives like powdered lime with equal quantities of rice powder are mixed with fine rices at the rate of 12·5 per cent or 5 seers per maund for

preserving them, for one year or more. If paddy is stored long in those areas where husked rice is subjected to prolonged and successful storage, the kernels tend to become brittle and are liable to heavy breakages on milling. Since paddy has lower cost of storage and the losses involved in carrying stocks in that form are less, it is necessary to investigate the optimum period of storage of rice in husk compatible with good milling, especially in the case of finer varieties, which are stored often for more than a year.

Humidity and Temperature in Store

Humidity.—Humidity and temperature inside the store as well as the dampness or dryness of the stored grain are factors of importance and bear direct relations with the climatic conditions of the locality. The amount of initial moisture in rice is mainly dependent upon the time and season of harvest. As the grain ripens in the head the percentage of moisture gradually goes down, and by the time of harvest it is normally about 15 per cent and it goes down to 10 to 12 per cent when stored in ordinary granaries. Moisture can be reduced further by redrying the rice, but unless it is kept in air-tight containers, it again absorbs moisture, the amount reabsorbed depending upon the climatic conditions of the tract. Though insect damage is probable even when the grain contains only 8 per cent of moisture, 10 to 12 per cent moisture can be safely left in the grain under ordinary circumstances. Kondo and Okamura[2] found that rice with moisture below 12 per cent can be stored in hermetically sealed containers for many years with little deterioration, and that in straw bags deterioration is serious after two years of storage. Hulled rice stored in dry concrete silos for five years resulted in little deterioration. Moisture content of the grain varies in direct proportion to the relative humidity. Robertson *et al*[3] found that samples of grain stored at 70°F and at or above 70 per cent R.H. suffered mould damage within two months of storing, while at the same temperature and at 90 per cent R. H. grains were damaged within a month ; at low R.H. (10 per cent moisture content of the grain) wheat, barley and oats were kept over 3 years without harm. Improperly dried or wet rice germinates in store, or gives high percentage of breakage on milling, the product often deteriorating rapidly in store. In the bulk storage of paddy the liability of damp through floor or walls affecting even well-dried materials cannot be ignored. In Assam, Bengal, Bihar, Orissa, and Central Provinces, the quantity thus affected does not exceed 0·25 per cent. But in Sind, where it is generally stored in open air heaps plastered with earth, damage due to damp may rise to about 2 per cent. Probably out of the marketable surplus of paddy about 10,000 tons equivalent to 7,000 of rice is annually affected by damp. Though relatively more careful storing is done in the case of husked rice, it may be affected by damp and become discoloured, except perhaps in the drier parts of the country. Par boiled rices discolour and become yellowish on storing ; and the bulk of the same is centred in areas subject to heavy rain and high humidity conditions which accelerate and accentuate discolouring tendency. However, parboiled rices are not stored long. Damp damage of husked rice in Assam, Bengal, Bihar, Orissa and Central Provinces range from 0·25 to 0·5 per cent and the estimated total quantity affected in the whole country may amount to 20,000 tons which on the discount value of 50 per cent would be equivalent to a nett loss of about 10,000 tons of rice, mostly from the urban areas.

Drying rate and air temperature.—Drying of paddy or rice depends upon the time and conditions of harvest or milling, pre-storage or milling treatment given to them, storage temperature and humidity, as well as the type of storage given. Slow controlled drying of the harvested produce is necessary as rapid drying in hot sun brings cross fissures or suncracks in the kernel making it unfit for milling. Bowden[1] thinks that not more than 4 per cent of the moisture should be removed at a time in a single drying, as the drying effect is mainly on the surface of the grain, leaving the interior portion unaffected. Air temperature above 120°F adversely affects milling by hardening the grain to the point of embrittlement and destroying the viability of seeds and sometimes cooking the grains. The critical temperature of rice storage is between 115° and 120°F and before the temperature reaches 115°F, rice must be transferred from one receptacle to another for cooling down. Moisture above 14 per cent of the weight of the grain sometimes induces increased respiration of grain and development of certain bacteria, causing local rise in temperature and even spontaneous ignition. Even grain with less than 14 per cent moisture content and up to 8 per cent may develop heat on account of insect activities with the result that it becomes wet blackened mass.

Chemical changes in Store

Fat-rancidity.—Stability of rice in storage presents a major problem from the nutritional standpoint; under certain circumstances, rice becomes rancid and loose nutrients during storage. Rice in husk is not so much affected as the hand-pounded or undermilled rices, as it is protected by the husk cover.

In the case of the latter the oil bearing bran layer surmounting the endosperm develops rancidity with long storage and causes rapid deterioration in odour and flavour. According to Lea,[5] it is primarily due to changes of the fat present in the grain caused by atmospheric oxidation which affects the unsaturated fatty acids by attacking at the double bonds with intermediate formation of oxides or peroxides, which then split to form aldehydes and fatty acids of shorter chain length. Kik[6] thinks it probable that a number of reactions occur simultaneously in this autocatalytic process and the enzymic liberation of free fatty acids may be partly responsible for the rancidity in rice though not wholly, as steamed rices also become rancid, while the action of micro-organisms also is a possible though less probable factor. Rancidification increases with humidity, hastened by exposure to light and slowed down by low supply of oxygen and low temperature.

Starch.—In relation to the damp damage and rancidity, other significant changes deleterious or otherwise, undergone by stored rices are worth studying. In matured rice starch is primarily affected in storage. Ramiah[1] thinks that during storage the process of ripening, initiated when the crop was in the field, continues and some of the complex carbohydrates are converted into simpler ones by the action of the enzymes, the moisture present in the grain at the time of storage and the conditions of storage influencing such changes. Bangalore experiments on changes of enzymic hydrolysis of starch during storage showed that as a result of storage there is decreased activity of amylases and an increased saccharification and liquefication at a given temperature. Well stored rice swells on cooking and is more digestible ; this is partly explained by Sreenivasan[7] on the basis of changes undergone by starch during storage.

Protein.—Protein content of rice is also changed in storage as is to be presumed from work in similar cereals. Jones and his collaborators[8] reported that ground corn and whole shelled corn after two years of storage showed decrease in the solubility of protein with a partial breakdown of the same, indicated by decrease in the true protein content and digestibility, the extent of the change being influenced by temperature, duration of storage, nature of the material stored as well as the type of the container used.

Thiamine, Riboflavin and Niacin.—Pearce[9] working on the effect of storage on the thiamine content and on the development of rancidity in wheat germ, found that protein is the chief factor involved in wheat germ spoilage and that little thiamine was lost in six months storage. Cailleau and collaborators[10] found that brown rice at 68°F under good conditions of storage of 6 months lost from 0 to 30 per cent thiamine, rice bran and polish lost 16 to 18 per cent and 50 to 67 per cent after 6 and 24 months of storage respectively, while parboiled brown rice in 6 months storage and parboiled undermilled rice in 3 months storage did not lose thiamine. Kik[6] found loss of thiamine, riboflavin, and niacin at 10·87, 6·34 and 4·12 per cents respectively for paddy ; 25·4, 4·2 and 3·87 per cents respectively for brown rice ; and 29·4, 5·44 and 3·77 per cents respectively for white rice after 2½ years storing. In ground kernel of the three, the loss of the nutritive factors was higher. Well polished white rice lose in storage more nutritive factors, especially thiamine, the anti-neuritic vitamin or vitamin B_1 than paddy, while the losses of riboflavin and niacin were comparatively insignificant.

Pest Attack

Insects.—Climate is an important factor in the insect damage of stored rices. Very high temperature correlated with low humidity, low temperature (below 55°F) as well as large diurnal variations of temperature are not conducive to insect life ; they thrive best in steady temperature. Warm humid weather as typified by coastal areas, and the monsoon periods are ideal for insect life. There are more than 50 species of insects which damage stored products of which a dozen are of primary importance.[11] The chief danger to the whole rice grain is from *Calandra oryza*, *Rhizopertha dominica* and *Trogoderma granaria* (species of beetles) and *Sitotroga cerealella*, *Corcyra cephalonica* and *Plodia interpunctella* (species of moths). Milled rices are damaged mainly by the two *Triboliums* and a number of secondary grain pests like the tiny *Laemophleus minutus* which are indicative of bad storage. Sometimes mites in large numbers occur in stores due to damp and other unhygienic conditions. There are two main kinds of insect attack, puncturing the grain and developing inside with eventual destruction of the grain, or feeding on the external part of the grain and increasing the polish of the undermilled rices. In urban areas of Sind, the Punjab and United Provinces, where paddy is not stored long, no serious damage from insects occurs not only due to the short period of storage, but also due to the dry atmospheric conditions and the low temperature which prevails during the harvest, post-harvest and milling seasons which are unfavourable to weevil development. But in other areas the damage ranges from 0·2 per cent of the total production in Bihar and Orissa to 2·5 per cent in Coimbatore, depending upon the place, period of storage and its nature. The total annual damage of paddy due to weevil infestation according to the Marketing Report[12] amounts to 30,000 tons in terms

of rice, while the loss in holdings in the rural areas is reckoned to about 45,000 tons aggregating to a total loss of 75,000 tons of rice in the shape of paddy alone. In husked rices, the nutritional inadequacy in certain respects makes highly milled rices unattractive to insects and they escape serious damage as they escape from rancidity. The hard smooth glassy surface and toughness imported to the grain during parboiling treatment helps the parboiled rice from insect depredation, while under-milled rice as in rancidification have to bear the brunt of insect attack. The Punjab and the United Provinces markets lose from 0·25 to 1·5 per cent by insect attack ; fine rice like *Basmati*, the annual storage of which amounts to 50,000 tons lose about 1 per cent of the quantity after the first year of storing. Elsewhere the insect damage loss ranges from 1·5 per cent in Bihar and Orissa to about 3 per cent in some areas of Bombay, depending upon the locality, duration, nature and season of storing. In the marketable surplus of husked rice stored, about 75,000 tons are annually lost in urban areas by weevil attack. The quantity of husked rice retained in rural areas is comparatively little, as the general practice is to keep the produce in husk, as is done in South India, Assam, etc. In areas where it is kept in husked form mostly for maturing purposes, in spite of preservatives and preventives, losses amount to 20,000 tons per annum. Thus the total loss of husked rice by insect attack in both the urban and rural areas together amount to almost a hundred thousand tons ; when the paddy destroyed also is added to this the total insect damage may come to 175,000 tons of rice annually.

Vermin.—Vermin damage to stored rice is equally serious ; a pair of rats is capable of producing about 800 rats in a year, and 100 rats can eat a ton (28 mds.) of grains in a year. The average vermin damage to stored rice ranges form 0·25 per cent in Madras to about 2 per cent in some areas of Bombay, depending upon the locality, duration and nature of store. Of the total quantity of paddy entering trade, about 40,000 tons in terms of rice is destroyed by rats and mice, which added up with losses from rural areas amounting to about 30,000 tons come to a grand total of 70,000 tons of rice destroyed annually as paddy. Further more, about 55,000 tons of husked rice are also destroyed of which about 40,000 tons occur in urban areas, while 15,000 tons are destroyed from rural parts which bring the annual damage by rats and mice to husked and unhusked rice to 125,000 tons.

Remedial Measures for Damages

Stored rice is mainly spoiled and destroyed by damp, temperature and pests ; the action of the three are complementary or supplementary ; the damp or temperature may start the rot, with mutual help or otherwise, giving way to weevils or vermins ; or the reverse may happen ; the contaminated grain brought for storing may cause heating or damp damages, with eventual destruction of the stored products. Thus the importance of clean dry grains, clean and dry storage receptacles and godowns and hygienic environmental factors are obvious. Some of the other fundamental requirements for safe storage of rice, whether underground or above ground, are that the moisture content of the grain should be below 14 per cent of the weight of the grain, the temperature of the store about 75°F and the relative humidity below 75 per cent. Coyne[13] opines that wheat producing area are the safest for grain storage, while the coastal areas are the most dangerous for prolonged storage of grains. Any godown designed to minimize pest and damp damage is good enough for the bulk storage of paddy. The ferro-concrete underground bins recommended by the Food Department is one of the best ; wooden receptacles too are good for storing both paddy and rice. Bulk storage is the best for paddy because of relative immunity from pest, protection from humidity, easy fumigation convenience for infected material, economy in gunny bags or minor storage receptacles, and indefinite storage, provided the godown is clean and dry and proof against moisture and pest. Bulk storage of grain in modern large scale silos, as a commercial venture, depends for success on the number of turnovers per year. Unless the production of rice is increased appreciably, and standardized, markets organized, and the assembling and transport system rationalized on an industrial basis, such large scale enterprises will not be a success in India. For storing in bags, *pucca* masonry godowns with stone or cement flooring is useful ; during storing direct contact with floors or walls is to be avoided.

Straw matting in *Kutcha* godown for bulk storage, and sleepers for bags in bag storage for clean pre-dried paddy may minimize damp damage. In husked rices which is rarely stored in bulk form, *pucca* flooring should be covered with matting. In humid areas damp and discolouration can be appreciably avoided by frequently airing and drying the material. Damage by burning is due to bad aeration and overheating of the stored material above the critical temperature of rice storage (115°F). When this occurs the store must be thoroughly overhauled changing the containers to cool the store. Rancidity is rare in the case of well milled rice, while it is not serious in parboiled rice as the quantity involved is not much, nor the duration of storage long. It affects undermilled and handpound rice. Though only about 26 per cent of the total supply of the latter is marketted, it is a serious

problem which can be tackled only by limiting the duration of storage and by more careful storing or by milling the rice to well polished stage at the rick of losing nutrient factors, especially when long storage is expected.

Insect control.—Insect damage of stored rice is more serious and necessarily call for preventive measures. The problem can be tackled from three aspects, prophylactic, preventive and remedial, which are to a certain extent inter-connected and complementary, while the main problem is well-ventilated hygienic rat proof storages and well dried clean grains. As the main prophylactic measures carbolic acid (phenol) or cresol, though ineffective as an insecticide and taint the grain, is an effective bactericide, 5 per cent cresol solution acting efficiently against mites, etc. Deodorizing the storage premises with solutions of bleaching powder or chloride of lime at the rate of ½ lb. in 10 gallons of water is a healthy practice. While in the preventive programme the indigenous methods like mercury in cowdung balls, cloves and pepper bags, dried tobacco and *neem* leaves, etc., are commonly practised in air tight receptacles. In the "inert dusts," katelsousse mixed at the rate of 1 per cent by weight of the grain is protective and preventive especially against weevils. New and effective dusts are mentioned by Kitchener and associates[14] and Wigglesworth[15]. Remedial measures against insect damages are by far the most important part of the storage problem; apart from heat and cold treatment, increasing or decreasing the temperature of the stores to a level when insect life is made impossible, contact poisons, stomach poison and fumigation are the means. Stomach poisons, like lead arsenate or sodium silicofluoride are inapplicable in storage of rice, as they poison the stored products, nor are the contact poisons like *pyrethrum* and *derris* sprays satisfactory, as they are not effective against hard bodied insects, if at all the spray manages to reach them. Fumigation in which the insecticide is taken in gaseous form through the spiracle of insects is a very effective method. Space for action for fumigants is available up to 40 per cent in whole-grain store and up to 60 per cent in finely milled products. Insects are active at high temperatures and best results of control are obtained then. There is a sort of natural fumigation in grains in store, if they are sufficiently packed tight in airtight containers; grains are alive and breathing, which is accelerated by the presence of moisture; the limited amount of oxygen present in the store is drawn upon by the grain, and if moulds and bacteria too are present they too compete for it with insects to replace it by carbon dioxide. This makes insect life impossible after some time and they are eventually asphyxiated in the increasing carbon dioxide atmosphere, though not before a damage up to 2 per cent has been done. Shepard and associates[16] found that resistance of different species of insects differ with the fumigants used, in the different stages of the insect life, and even in the same species of insects. A similar reaction exists between the vapours of different fumigants and the constitution of different grains usually stored, making the fumigation problem complicated. However, a good fumigant must be highly toxic to insects and other pests, while non-toxic to man and his pets, must be easily detectable and non-inflamable, not highly absorbed by the stored products, and must be economical and easy of transport. Hydrogen cyanide and its various forms and concentrations as Calcid, Cyanogas, Oymag, etc., are highly efficient fumigants; but well trained personnel are required for handling them. There is fire haphazard in carbon bisulphide and ethylene oxide; methyl bromide is toxic to man; chloropicrin is lachrymatory and affects viability of seeds; methyl formate is dangerous; paradichlorbenzene spoils grain, and ethyl formate is weak; while sulphur dioxide is corrosive to metals and damages the grain. According to Coyne, ethylene dichloride and carbon tetrachloride mixture of 3 : 1 is effective for bulk grain with bottom trap arrangement for discharge of grains, and for fumigating empty bags in closed bins. D.D.T. at 5 per cent strength and Gammexane at 0·0006 concentrations are effective at 14 per cent moisture content of the grain at 80°F; half a pound of Gammexane dust D ·034 is sufficient for 100 sq. ft. of store.

Vermin Control.—The only remedy to offset the huge annual waste due to vermin is to destroy the pests and to store rice beyond their reach. Rats and mice multiply wherever cover, food and water are available. The first control measure is to avoid giving them these living conditions. Ratproof godowns should be built; and if open storage is unavoidable, it should have a 3 ft. high plinth with projecting rat traps or ratproof walls. Rats must be destroyed systematically by complete survey, simultaneous eradication campaign, by mechanical traps, poison baiting (by zinc phosphide, arsenious oxide, barium carbonate, etc.) and cynide gassing, etc.

Conclusion

The quantitative estimate of the loss by damp, burning, rancidity, weevils and pests, both in rural and urban areas, amount to about 317,000 tons of rice per annum or about 1·12 per cent of the average rice production of the three years from 1943 to 1946; about 448 per cent of this destruction is as paddy, while the rest is as husked rice. At a very conservative estimate of Rs. 3/8/- per maund of rice this

enormous damage in India works out to more than three crores of rupees per year.*

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Notes and News

COLLABORATIVE EFFORTS OF SCIENTISTS

UNITED STATES have become a gathering ground for scientists for the purpose of exchange of news and also extending the frontiers in the matter of international co-operation in scientific activities. The Chief of the U. S. Weather Bureau had visited Russia in the summer in 1945 and made plans for an exchange of weather experts between the countries. There was in the intervening period shortage of trained meteorologists in the United States. Now weather data from Russia and Siberia are coming into the Weather Bureau several times daily. It is sent in the international code and picked up by the United States Navy Stations at the Pacific Islands. The Navy relay the data to Weather Bureau Stations on the West coast of U. S. and from there they are sent to Washington. Similarly, regular weather reports are being sent to Russia under a mutual agreement. It is reported that the agreement will be a subject of discussion at the International Meteorological Organization which is meeting soon. This organization was founded in 1878 and membership has no political bias. Together with this news, we have another American source stating that Swedish scientists are visiting United States. Arne Tiselius of Uppsala University, the Chairman of the Swedish Natural Science Research Council, will study the application of isotopes to medical and biological research. Two other Swedish scientists are coming for atomic study in New York, Boston and Chicago.

To co-operate with the Stanford Research Institute in a $150,000 scheme for production of natural rubber from Mexican guayule plant (*Parthenium argentatum*) sponsored by the office of Naval Research, the Cambridge plant geneticist Dr D. G. Catcheside will spend six months in studying the genetics of the plant. Dr Catcheside has to his credit studies on the effects of ionizing radiation on hereditary characterists and is a member of the British Ministry of Labour Panel on industrial protection and radiation.

From India also Dr H. K. Sen of Allahabad University is proceeding to Harvard Observatory on the invitation of Dr Harlow Shapley to continue his work on stellar energy. Mr C. R. Bose of Calcutta University has been appointed visiting professor of mathematical statistics at Columbia University and North Carolina University (U. S. A.).

CYCLOTRON IN SWEDEN

SWEDEN will probably be the only country in Europe to possess the latest equipment for nuclear

studies. The Nobel Institute of Stockholm under Prof. M. Siegbahn has nearly completed the construction of a cyclotron. The second cyclotron is being erected under the auspices of the Physico-Chemical Institute, University of Uppsala. The estimated expenditure is Rs. 2,500,000 which is being met jointly by Swedish industries and Swedish Government. This cyclotron is expected to be completed in 1948 and will weigh 640 tons. It is hoped that it will attain energies of 60,000,000 electron volts for nuclei of heavy hydrogen and 120,000,000 volts for ordinary hydrogen nuclei. At the beginning, it will be used for medical and nuclear research by the Institute staff under the Svedberg. The industries will sponsor work on uses of radiation in production of textile materials and in the chemical industry. It is reported that this cyclotron will form the centre of a number of laboratories devoted to different branches of science. Three scholars from Palit Laboratory of Physics of Calcutta University are on their way to Sweden on study tours..

HISTORY OF SCIENCE

A MOVEMENT, which has gained particular momentum in the United States, is the study of history of science as an essential course for all science students. It is now realized that scientists must have a background and also the prospective view of the implications of works already done and the work which they desire to undertake in order to lead the results to fruitful utilization for the society. It is not always the guiding principle of scientific activity that some utilitarian motive should underline the work but many developmental aspects can be foreshadowed if a knowledge of the development of scientific thoughts and results is available to the workers. The History of Science Society is awarding a 100-dollar annual prize to an undergraduate or first-year graduate student in the United States or Canadian college, university or professional school for the outstanding original paper on some aspects of the history of modern science. The period is mentioned to be between 1600 and 1915 and papers may deal with any of the natural sciences or in mathematical, enginering, or agricultural subjects.

PERFUMERY INDUSTRY IN INDIA

RENOWNED through the ages as the home of spices and perfumes, India is still now the richest country for aromatic plants. The demand for varied and delicate perfumes, is bound to increase with the development of the aesthetic sense following the advancement of science, increased prosperity and a higher standard of living. In addition, essential oils have important or repellent properties for insects and could be used for devising snares to destroy animal, agricultural and forest pests.

India's share in the world trade of essential oils is significant but hardly commensurate with her resources. The total imports of essential oils and synthetic odorants to 19 principal countries in 1935 amounted in value to about Rs. 1,00,000,000. During the two years preceding World War II, India imported essential oils worth about Rs. 1,700,000 annually and their average exports amounted to about Rs. 25,00,000, while the average annual exports of essential oil-bearing raw materials (mostly spices) amounted to about Rs. 7,800,000. A vast improvement in this trade is not only possible but can be easily effected.

The need for a detailed survey and a study of all the aromatic plants in India numbering not less than 1,300 and comprising about 10 per cent of the total species of flowering plants recorded in India has been further stressed in an article in the *Journal of Scientific and Industrial Research*, May, 1947. Scientific breeding and cultivation is necessary for a greater yield of essential oils and production of exquisite perfumes.

A description of five families of flowering plants with coloured illustrations containing detailed information on India's 65 important aromatic plants is also given.

BOTANICAL GARDENS FOR MOSCOW

THE Academy of Sciences of the USSR has entrusted Academician N. Tsitsin with the task of laying a new Botanical Garden in Moscow. Joseph Stalin has taken a personal interest in the matter and expressed the wish that the new gardens be the biggest and richest in the Soviet Union. An area of about one thousand acres has been set aside for the new gardens and the chief objective will be the study of the best ways and means of utilizing the country's rich flora for the socialist national economy.

Much attention will be paid to tree planting, cultivation of decorative plants and creation of parks and gardens in the rehabilitated Nazi-ravaged towns.

The gardens will likewise be a centre for spreading knowledge on applied botanics and reveal the wealth of the country's flora and features of vegetation in each republic, from the northern taiga to the southern sea coast.

Not only soviet flora but also plants from all over the world will be represented in the gardens. The agricultural plants, from their wild ancestors to the present descendents, will be presented in a

way reflecting most vividly Darwin's evolutionary theory of the origin and development of plants, particularly as a result of man's labour.

The plan further provides for the construction of laboratories, museums, herbariums, libraries and lecture halls and extensive experimental plots to enable scientific workers to conduct experiments and research on a large scale. The origin and evolution of cultivated plants, like potatoes, cotton, flax, strawberry, and fruit trees and the physiological and biochemical processes in plants, particularly the texture, formation and disintegration of the structural albumens and ferments are being studied. Interesting experiments are being made on rejuvenating plants by surgical methods and by changing regimen of water, light and nutrition.

The Soviet specialists in the field of botany and horticulture desire to establish contact with workers abroad and receive advice and exchange with them catalogues, manuals and other publications on seeds and plants. (*Soviet Science*, April, 12, 1947).

LAUNDRY RESEARCH

Scientific research is now trying to use the principle of the Asdic submarine detector for removing dirt from clothes. Speaking to the British Launderers' Research Association, Sir Edward Appleton, Secretary, Department of Scientific and Industrial Research said that good progress was being made in this research and success will change all the processes of laundering.

It has been found that dirt is often held to a fabric by electrical attraction and the problem in the removal of dirt from fabrics is to break this electrical attraction. Supersonic vibrations are now being used to shake out the dirt particles by the British Launderers' Research Association and emulsify them in the cleansing solution. This will prevent the dirt being deposited again on the fabric.

Economy in fuel consumption has also been effected, by laundries following the advice of the Research Association. In one laundry coal consumption is reduced from 800 tons to 600 tons a year. In another, 42 per cent of the fuel previously used is saved by the use of electric motors instead of a steam prime mover.

The Research Association is further engaged in the testing of a new design for a thermostatically controlled iron, new washing machines, new sorting apparatus, new soaps, etc.

Cross infection from blankets used in hospital wards was a problem that defied solution for a long time. An oiling process, evolved by the Association, has largely solved the problem. (*Department of Scientific and Industrial Research*, London, May 1, 1947).

FORECASTING MONSOON RAINFALL

It is sometimes possible to foreshadow the weather conditions in a particular part of the world several months ahead from a knowledge of the antecedent weather conditions in certain other parts of world. The India Meteorological Department commenced issuing long range forecasts of seasonal rainfall in India in 1886 and has for more than 50 years continued the attempt to foreshadow monsoon rainfall and the winter rainfall over certain parts of India.

The basis of this method of long-range forecasting developed by Sir Gilbert Walker (a former Director-General of Observatories) and now used in the department is the method of correlations. It consists in determining a few major factors that have significant relationships with the rainfall to be forecasted, in finding the correlation of those factors with the rainfall and also among themselves, and thence to obtain the linear regression and multiple correlation coefficient. The extensive and intensive searches carried on over a number of years yielded a large number of factors, local as well as extra-Indian which appeared to show certain relationship with Indian rainfall. A selection out of the numerous factors so formed was made by applying a test of significance known as Walker's test. The factors obtained for forecasting monsoon rainfall in the peninsula are South Rhodesia rainfall, South America pressure, Dutch Harbour temperature and Java rainfall. With the help of these factors it is possible to form a linear regression equation which gives the departure from normal of the monsoon rainfall in the peninsula.

In the *Scientific Notes, Vol. 9, No. 101, 1946,* (of the India Meteorological Department) the authors have correlated the various meteorological factors found useful for forecasting the monsoon rainfall in India with the sub-divisional monsoon rainfall for the twelve divisions in peninsular India, and regression formulae worked out. The usefulness of this formulae for forecasting is tested and it is shown that they may be expected to give forecasts of the same order of precision as for the 'peninsula' as a whole.

A NEW ATOMIC ENERGY LABORATORY

Very few in this country including most of our scientists and national leaders seem to have any idea of the vast facilities and resources needed for an up-to-date atomic energy laboratory. The following

account of the proposed reorganization of the Argonne National Laboratory, published in "*Science*" will, it is hoped, dispel some illusions.

The proposed laboratory will be situated 26 miles to the south-west of Chicago, Illinois. This site has been found most suitable from the consideration of geographical location, transportation facilities, the type of foundation, availability of sewage, water and power facilities. There will be some 12 large buildings to accommodate the administration, physics, biology, medical and engineering research, nuclear reactors, etc. It is expected that the whole laboratory will be completed in 3 years. For future expansions and further developments, a total area of about 3,645 acres have been acquired all round the laboratory.

Under the present arrangement about 25 participating academic and research institutes such as Chicago University, University of Illinois, Carnegie Institute, North Western University elect one representative each. This council of 25 members elect a board of 7 Governors for the laboratory who review general matters of policy and make recommendations to the Government.

'3,645' acres is over five square miles. The Nuclear Energy Station will therefore have the size of a medium sized city. The power requirements are not given, but no doubt it will exceed the present power supply of all Indian cities, except Calcutta and Bombay.

HYDRAULIC ACCUMULATOR

The development of a novel type of gas-filled hydraulic accumulator for constant pressure operation has been developed in Russia by J. Kurlovits & F. Svindenkov, ("*Zheleznodorozhni Transport*," Russia, No. 4, 1946, p. 84). In this accumulator the required pressure is created not by compressed air but by a gas which evaporates at the temperature and pressure prevailing in the hydraulic accumulator. For any variation in the water contents of the accumulator, the prevailing pressure is solely governed by the temperature. However, the latter remains constant during the operation of the accumulator and the accumulator pressure also remains constant. Owing to the slow rate at which the periodic expansion and contraction of the gas proceeds during the operation of the accumulator, sufficient time is available for temperature equalization of the accumulator contents with the circumambience to take place. The arrangement consists of a steel drum with an outlet connected to the hydraulic system. A mixture of methane and propane serves as working gas, the actual proportion of the mixture being chosen according to the pressure required. Thus for a working pressure of 3 atms. and a 200 cub.m. capacity, a mixture of 50% butane and 50% propane can be chosen. Then for a working temperature of 6° to 10°C the quantity of condensed gas works out to 2,400 litres by volume or 1,310 kg. by weight. In view of the low specific gravities of both liquid butane and propane (0·545 kg. per litre of the condensed gas), the mixture will always float upon the water surface. Moreover no mixing of the butane—propane mixture will occur, nor will the mixture react with the water contents of the accumulator. The useful working volume of an accumulator is very high. Theoretically, it amounts to 98·8% of the gross volume and 95%, if allowance for slight leakage is considered. This figure is far higher than for any other accumulator yet known. Besides giving a practically constant pressure, the hydraulic accumulator is quite simple in construction, reliable in operation and economical in that it utilizes some 2 to 2½ times less steel per cub.m. of volume as compared with other usual types.

It is usual practice to install for hydraulic presses a central accumulator plant connected with the individual presses by a high-pressure pipe system operating at 200-250 atms., the accumulator capacity varying from 500 to 1,500 litres of water. For such plants ethylene is used as a working gas, the vapour pressure of which amounts to 50·8 atms. at 10°C. For railway water supply service, the accumulator vessel is usually buried underground in order to prevent the freezing of water as well as to keep it at a constant temperature.

S. K. G.

HIGH PRESSURE VESSELS

The revival of the German technical press has brought about the inauguration of about ten highly scientific journals, crammed with interesting articles, some of which reveal for the first time the highly progressive engineering developments in Germany. The present note is abstracted from *Die Technik* which is published by the newly opened Kammer der Technik in Berlin, and to all appearances this journal is the successor to the former well-known *V. D. I. Zeitschrift*.

Progress in Germany since 1935 on the engineering development of high pressure vessels with a completely new approach to their design is described by the authors of this article, E. Siebel and S. Schwaigerer. A comparatively thin walled inner cylinder is made of hydrogen resisting alloy steel while the high pressure is taken care of by outer cylinders made of boiler steel. The forged vessels made in one piece by very heavy hydraulic presses were superseded by multilayer vessels of various types.

The forged thick walled cylinders were replaced by several thin walled cylinders fabricated by welding and shrunk on to the high alloy core. The shrinkage due to welding assists in closing the gap between individual layers and the vessel is capable of withstanding pressures up to 400 atmospheres. Pressure tests with very high pressures indicated however that in this layer type design, after partial plastic deformation takes place the unequal balancing of loads on various cylinders have to be fully taken into consideration to enable these containers to withstand pressures above 400 or 500 atms. The development of banded vessels avoids this practical disadvantage. Such vessels consist of a core cylinder with a series of profiled bands wrapped spirally around the core. This construction is based on the principle that with a hollow cylinder under internal pressure the axial stress is only half the tangential stress. The profiled bands take up the tangential load, and owing to their stepped surface, transmit a part of the axial load also, thus relieving the core cylinder which can then be constructed as a thin shell of high quality alloy steel. The bands are usually electrically heated to 500°-600°C and wrapped round the core in a staggered form so as to cover the gaps of the preceding layer. Banded vessels are capable of standing very high pressures and show, according to tests, ample deformation before failure, which is mainly due to their monolithic behaviour under internal pressure.

The development of this new technique of designing high pressure vessels, will, it is believed, exert a profound influence on the progress of manufacture of modern synthetic chemicals as well as in other fields of chemical engineering (*Die Technik, 1, No. 3, Sept., 1946, p. 114*).

S. K. G.

INTERNATIONAL CONGRESSES

The next *International Congress of Physicists* will be held at Bordeaux (France) in April, 1948.

The Fourth International Cancer Research Congress will be held in St. Louis, Missouri, U.S.A., during September 2-7, 1947. The Congress will be held under the joint auspices of 'The Internationale centre le Cancer' and 'The American Association for Cancer Research' with Dr E. V. Cowdry, Professor of Anatomy, Washington University School of Medicine and Director of Research of the Barnard Free Skin and Cancer Hospital as president of the Congress.

The Eighteenth International Geological Congress will be held in London, during August 25 to September 1, 1948 under the auspices of the Geological Society of London. A. J. Butler, Esq., of the Geological Survey of Great Britain and Dr L. Hawkes, Bedford College, London are the General Secretaries and abstracts of papers to be presented at the Congress should reach them before May 14, 1948.

The World Statistical Congress which is being convened by the U. N. Economic and Social Council, the *International Statistical Institute* and the first *Inter-American Statistical Institute* will meet at Washington, U. S. A. in September next.

LADY TATA MEMORIAL TRUST AWARD FOR 1947-48

The trustees of the Lady Tata Memorial Trust announce the award of the following Scholarships and Grants for the year 1947-48:

I. International award for research in diseases of the blood with special reference to Leucaemias are made to: Dr Jorgen Bichel, Denmark; Dr Pirre Cazal, France; Dr Pierre Dustin, Belgium; Dr Maurice Guerin, France; Dr Simon Iversen, Denmark; Dr Joseph Japa, Poland; Dr Edith Paterson, Great Britain; Prof. Edorado Storti, Italy; Dr Peter A. Gorer, England; Dr Johannes Clemmesen, Denmark; Dr C. F. M. Plum, Denmark; Dr Tage Kemp, Denmark; and Dr Guido Totterman, Finland.

II. Indian scholarships for investigations having a bearing on the alleviation of human suffering are awarded to Messrs Suprobhat Mukerji (Chemistry), Kalyanmoy Mukerji (Physiology), Naresh Chandra Ghosh (Biochemistry), of the University College of Science, Calcutta; Messrs P. R. Gupta (Chemistry) and Yashwant Balkrishna Rangnekar (Biochemistry) of the Indian Institute of Science, Bangalore and Mr Haridas Brahmachari (Biochemistry) of the Nagpur University, Nagpur.

ANNOUNCEMENTS

Sir Ardeshir Dalal has been elected President of the Indian Institute of Science, Bangalore *vice* Sir M. Visvesvaraya, retired.

Prof. M. N. Saha has been elected a member to the American Academy of Arts and Sciences. The A. A. A. S. founded in 1780 is the second oldest learned society in the U. S. A. Among its foreign members, the Academy counted Humboldt, Faraday, Darwin, Helmholtz, Kirchoff and others.

It is this Association which awards the famous Rumford Medal every two years on the most significant investigations in Natural Philosophy.

Mr. R. C. Bose, M.A., F.N.I., head of the post-graduate Department of Statistics, Calcutta University, left for U. S. A. to attend the Statistical Conferences in Washington and to deliver a series of lectures at several American Universities.

An embargo having been placed on all discussions connected with Atomic Energy, the subject could not be discussed at the *11th International Congress of Pure and Applied Chemistry* recently held in London. This corrects our announcements about the Chemistry Congress published in last July issue. After we had gone to press, the news was received.

The Congress adopted the following resolution: "The eleventh International Congress of Pure and Applied Chemistry declare their wish that in future the science (chemistry) must be applied only to establish good relations and fraternity among different countries of the world."

Dr Ajit Kumar Saha, D.Sc., a Premchand Roychand student of the Calcutta University has been awarded 1857 Exhibition Scholarship to enable him to prosecute his higher studies in Nuclear Physics abroad. He was until recently working on β-ray spectroscopy and Nuclear Physics in the University College of Science, Calcutta as a junior research fellow of the National Institute of Sciences of India. Dr A. K. Saha is the eldest son of Professor M. N. Saha, F.R.S.

ERRATA

In July, 1947 issue, p. 33, column 2, line 6 *read* "of Calcutta mycologists, working under the inspiring guidance of Prof. S. R. Bose. Cytological basis . . . ." *for* "of Calcutta mycologists. Working under the inspiring guidance of Prof. S. R. Bose, cytological basis . . . ."

P. 34, column 2, line 20, *read* "Science" *for* "Welfare".

P. 38, column 1, line 44, *read* X=degree of acetylation *for* X=per cent acetic acid content.

BOOK REVIEWS

The Purums—An old Kuki Tribe of Manipur—By Tarakchandra Das, M.A., University of Calcutta. Price Rs. 10/-.

Small though it is in numbers (it contains only some 300 souls) the Purum tribe is of interest to scientists because it is in a transitional stage. Living as they do on the lower slopes of the hills bordering the Logtak lake in Manipur State, the Purums are in constant contact with Manipuri culture proper, some of which they have inevitably absorbed. For instance, primitive *jhuming* has been abandoned in favour of plough cultivation. The special interest of the book for sociologists is that it describes a culture clash not unlike those occurring elsewhere in India, where primitive cultures impinge on more advanced. The Hindu Manipuris, to use the words of the author "look down upon the Purums as something less than human beings". On the other hand, and partly on account of the attitude of the Hindus "the hill tribes of Manipur are now growing into a consciousness of unity among themselves as against the Hindu dwellers of the valley". The author shares none of this prejudice and his liking for the Purums is absolutely sincere. He cannot blame the hillmen for their unity, but he does blame the Manipuris for the hostility which has caused it. His book is far more than a record of a tribal culture. It is first and foremost a mine of materials and suggestions for the improvement of the lot of the tribesmen on the one hand and the dissipation of cruel and unwarrantable prejudice on the other. The lessons it contains are applicable over a wide field.

J. P. M.

Alfred Adler—By Phyllis Bottome. Pp. 279. Published by Faber & Faber Ltd., London. Price 12s. 6d.

The book is a biography of Dr Alfred Adler, founder of the school of psychology commonly known as Individual Psychology. As the book is written by one who was intimately associated with Dr Adler's activities over a long period many episodes of his life are recounted in it which may be of interest to those who may feel interested in the scientist's per-

sonal life. A limited space has been devoted to Dr Adler's actual work.

A book of this nature might have been of more value if the facts were used objectively and more dispassionately. Secondly, it is regrettable that personal relationship between Adler and Freud have been narrated in a vein which is not desirable. Even if it be accepted that there were grounds for mutual recrimination during the life time of Freud and Adler, it is of less use to carry on the 'feud' after their death. It does neither help science nor scientists.

N.M.

I Saw Yugoslavia—By Gautam Chattopadhyaya (Diary of three weeks in the land of partisans). Pp. 46. People's Publishing House, Bombay, 1946. Price As. -/8/-.

Books like this, intimate, factual and revealing, have been plentiful about Russia ; about Yugoslavia there have not been many, at least not many are known to us,—and therefore we welcome this timely little publication. Here we see how much can be achieved and how much more can be expected when a people makes up its mind to express itself in all departments of life. Mr Chattopadhyaya has taken us right inside the heart of the country about which he writes with so much well-placed enthusiasm and intimacy. That he was a member of a students' organization is all to the good, since the informed enthusiasm of his generation is the capital upon which the future of our country can draw with confidence.

D. G.

India & U.N.O.—By Mohan Kumaramangalam. Pp. 46. People's Publishing House, Bombay, 1946. Price As. -/8/-.

At the U.N.O., the Indian delegation achieved a notable success as against the Hitlerite enactments of the South African government, thanks largely to the powerful support they obtained from Russia and the group of nations that has gathered round her. Mr Kumaramangalam has done well to place before us an unusually interesting resume of the various proceedings that led up to India's final success, and against the background of international manoeuverings, his story is not only interesting but instructive as well. India should now be in a better position to know how to save the U.N.O. in the great crisis which is already looming in the horizon ; never before was it so necessary for the world that it should be saved in order that civilization may survive the conspiracy of vested interests.

D. G.

Luther Burbank, a Victim of Hero Worship—By Walter L. Howard, Ph.D. Illustrated. Published by Waltham, Mass., the Chronica Botanica Co., Calcutta, India, Macmillan & Co., Ltd., Vol. 9, No. 5/6 (Pp. 299-522) of *Chronica Botanica*. Price $3·75.

Luther Burbank was the most well known plant breeder the world has ever produced, and his life and achievements have been a great source of inspiration for practical plant breeding. While he had many admirers in his own country and abroad, he had also a large number of critics, who condemned him and his activities. Consequently, a big volume of literature has grown round Burbank and his work, but no where an attempt has been made to study his career objectively. It is this gap the present volume is intended to fill up. It is essentially a collection of analyses of different aspects and events of Burbank's colourful career, supported by meticulous collection of historical accounts, and in presenting them, the author has been imbued with a spirit of fair play.

The value of the present volume is increased by the inclusion of a few photographs of Burbank and his farm and also a few facsimile of Burbank's original catalogues. His short life sketch and a summary of his more important productions are useful additions, which will, no doubt, be much appreciated.

We recommend this unbiased, scholarly account of Burbank to our readers.

J. K. C.

Goéthe's Botany—By Agnes Arber, D.Sc., F.R.S. Illustrated. Published by Waltham, Mass., the Chronica Botanica Co., Calcutta, Macmillan & Co., Ltd. Vol. 10, No. 2 (Pp. 63-126) of *Chronica Botanica*. Price $2·00.

Goethe is well known as a poet and philosopher, but that he was also a botanist and took life-long interest in Botany, is not known to many. His studies of plants began with their descriptions, which naturally led to those of comparative morphology, but the poetic mind did not stop there, instead, it soared up into hypothetical region beyond the domain of science. Nevertheless, his contributions are a significant chapter in the history of Botany,

and the author has done a distinct service by bringing out this edition in which are included translations of Goethe's Metamorphosis of Plants and Fragment. Her critical introduction is of great help to understand Goethe's work in their proper perspective.

J. K. C.

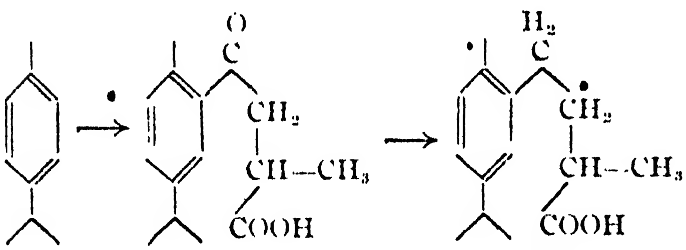
LETTERS TO THE EDITOR

[*The Editors are not responsible for the views expressed in the letters.*]

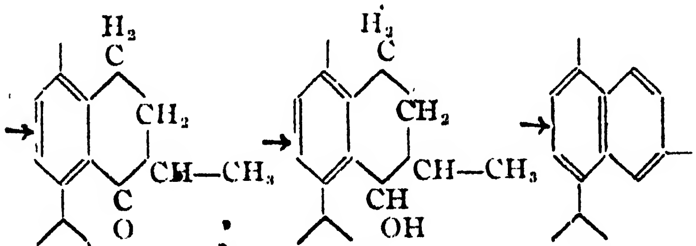
STUDIES IN SESQUITERPENES

Part I: A New Synthesis of Cadalene.

CADALENE, the important dehydrogenation product of some of the sesquiterpenes, was originally synthesized by Ruzicka and Seidel[1] by a comparatively lengthy procedure. A new and much simpler procedure for its synthesis has been achieved.



(I) (II)



(III) (IV) (V)

p-Cymene was condensed with methylsuccinic anhydride in nitrobenzene in presence of anhydrous aluminium chloride to give a keto-acid, m.p. 118-119°. The structure of the keto-acid as α-methyl-β-(p-cymoyl-2)-propionic acid (I) was established by a straight forward synthesis, starting from 2-acetyl-p-cymene. 2-Acetyl-p-cymene[2] was brominated with one mole of bromine; the resulting ω-bromo-compound was condensed with ethyl methylcyanoacetate. The cyno-ester was hydrolyzed and then decarboxylated at 160-170°. The resulting acid melted at 118-119°; mixed melting point with the Friedel-Craft's condensation product (I) remained underpressed.

The keto-acid was reduced by Clemmensen's method using Martin's[3] modification, yielding a colourless slightly viscous liquid, b.p. 182-85°/6 mm. The α-methyl-γ-(p-cymyl-2)-butyric acid (II) was cyclized with aluminium chloride, via the acid chloride to yield the corresponding tetralone (III), b.p. 136-138°/2 mm. The tetralone was reduced with sodium in moist benzene to give the secondary alcohol (IV) which was dehydrated with anhydrous formic acid. The resulting hydrocarbon, b.p. 132-138°/9 mm. was completely aromatized by dehydrogenation with selenium to give cadalene (V) which was identified as its picrate, m.p. 115°, and styphnate, m.p. 138°. Mixed melting point of this cadalene picrate remained undepressed with an authentic sample obtained from a natural source.

SUKH DEV
P. C. GUHA

Organic Chemistry Laboratories,
Dept. of Pure & Applied Chemistry,
Indian Institute of Science,
Bangalore, 19-12-1946.

1 Ruzicka and Seidel, *Helv. Chim. Acta.*, 5, 369, 1922.
2 Allen, Organic Syntheses, *14*, 1-3, 1934.
3 E. L. Martin, *J. Amer. Chem. Soc.*, 58, 1438, 1936.

EFFECT OF SESAME OIL ON 'VEGETABLE GHEE' FORTIFIED WITH VITAMIN A.

'VEGETABLE GHEE' is, now-a-days, being largely consumed as a dietary fat. But the unsaturated fatty acids like linoleic or arachidonic acids that are believed to play a role in human nutrition[1], are mostly lost during hydrogenation. Addition of some fat like sesame oil rich in linoleins, is being suggested for making up the above deficiency in the "vegetable ghee". This may also help in assimilation of the fat by increasing its fluidity. Again fortification

with vitamin A is being further advocated (*cf.*, Daniel[2]) for enriching the food value of the fat. But it has been recently noticed[3] from this laboratory that vitamin A itself is not so stable in presence of sesame oil. Accordingly, investigations have been undertaken to study the influence of sesame oil in maintaining the potency of vitamin A when present in fortified 'vegetable ghee'.

A brand of 'vegetable ghee' (124·37 gms.) as purchased from the market and exhibiting an acid value of 1·3, was mixed with a vitamin concentrate (0·63 gm.) containing 2,00,000 International Units of vitamins A per gramme in a sterile glass container fitted with air passing arrangement. The preparation was marked as V. Similarly the same ghee (118·15 gm.), sesame oil (6·22 gm.) washed free from free acids and purified, and the above vitamin concentrate (0·63 gm.) were mixed in another bottle and this was marked as preparation VS. Air led through a bottle containing caustic potash solution and another containing concentrated sulphuric acid was continuously passed through the above two preparations under identical conditions on keeping the bottles in water bath maintained at near about 40°C. The vitamin A potency of the preparations were

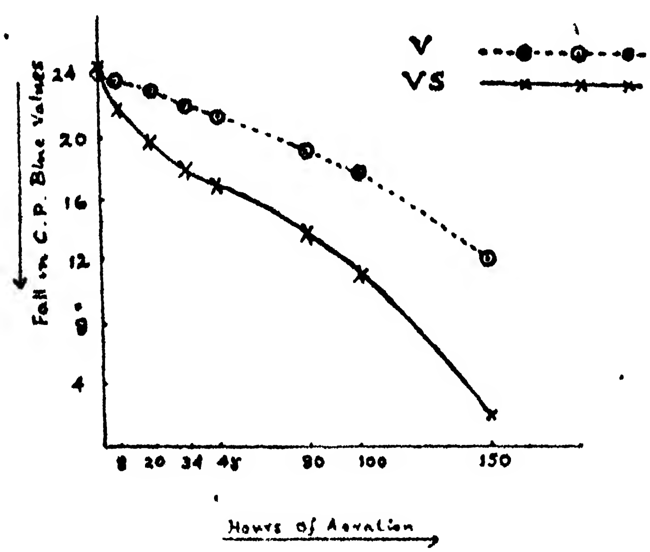


FIG. 1

determined in terms of Carr-Price blue by a Lovibond tintometer from time to time by taking out an aliquot part of the preparations. The relative fall in Blue values in the two preparations V and VS might be noticed from Fig. 1.

From this preliminary investigations it appears that incorporation of sesame oil (5 per cent) to vegetable ghee (*cf.*, the curve VS in the graph) definitely lowers the keeping properties of vitamin A in vegetable ghee. The ghee itself as evident from the curve V, is not also maintaining the vitamin potency and for which the effect of incorporation of some suitable antioxidant may be studied. But as sesame oil is being noticed to exert a direct influence in the destruction of vitamin A in the fortified vegetable ghee, its incorporation cannot be advocated. Similar influence of other edible oils rich in linoleins (such as cotton seed, ground nut or, maize) are being studied.

U. P. BASU
N. RAY

Bengal Immunity Research Laboratory,
Calcutta, 20-5-1947.

[1] Hansen, A. E. and Burr, G. O., *Jour. Amer. Med. Assoc.*, *132*, 855, 1946.
[2] Daniel *et al*, *Science*, *98*, 189, 1943.
[3] Sen Gupta, S. K., *Jour. Ind. Chem. Soc.*, *23*, 233, 1946.

ON THE MOISTURE CONTENTS OF QUININE SULPHATE

THE quinine sulphate of the British pharmacopoeia has a moisture content corresponding to about 7½ molecules of water of crystallization, but this salt is unstable and loses water on exposure to air. The consequent loss of weight and alteration in strength often becomes a source of difficulty in the evaluation of the drug as has been recently pointed out by Das and Sen Gupta.[1] Some loss of moisture occurs even when the salt is packed in well-closed containers and disputes in business transactions arising out of the consequent decrease in weight in transit or storage are not uncommon.

The dihydrate of quinine sulphate, which is formed when the official salt is exposed to air or heated at 50°C is a more stable salt[2] and suggestions have been made in the past to replace the present official quinine sulphate by the dihydrate. But this has not met with general approval, particularly on the part of the manufacturers, due to the fact that at this moisture level the salt loses its silky crystaline appearance and light texture which are looked upon by the trade as signs of quality.

The uncertainity of the moisture content of quinine sulphate, as obtained in the market, renders its moisture determination of secondary importance in its analysis. If the limits of moisture as set out in the B. P. were to be strictly adhered to, the best quality of quinine sulphate would have to be rejected simply because it had lost some water. The most rational procedure would be to express the quantity of quinine sulphate (or of any other quinine salt) in terms of the actual quinine alkaloid content, based

on analysis, irrespective of the actual weight of the salt which, in any case, is an unreliable index.

S. MUKHERJEE

Bengal Immunity Research Laboratory,
Calcutta, 26-5-1947.

[1] Das, B. K. and Sengupta, S. B., SCIENCE AND CULTURE, *12*, 555, 1947.
[2] Thorpe's Dictionary of Applied Chemistry, III, 4th Edition, p. 173.

GALLIUM CONTENT IN INDIAN BAUXITES

THE chemical estimation of trace quantities of Ga is a complicated problem. This involves its separation from all interfering ions. Of the various methods suggested from time to time the colorimetric method developed by H. H. Williard and H. C. Fogg[1] using quinalizarine is the most promising. They described various methods for its separation from interfering ions But nothing was mentioned about its separation from excess of Ti. Indian bauxites contain traces of Ga and also a large amount of Ti. This investigation was started to devise a method for the separation of Ga from Ti, with the ultimate object of estimating the Ga thus separated. The classical method of Lecoq[2], *i.e.*, the use of arsenic sulphide as a collector from a weakly acetic acid solution failed beause some Ti was always coprecipitated by hydrolysis. By a modification of the ether extraction method of D. C. Grahame and G. T. Seaborg[3] the Ga was separated in a pure state and estimated colorimetrically with quinalizarine at pH 5. A synopsis of the procedure is given below, the details of which will be published elsewhere.

The ore was decomposed with four times its weight of fused alkali. The melt was dissolved in water and the residue freed from any adsorbed Ga by repeated washing with 0·5 N alkali (tested spectroscopically). Traces of colloidal iron from the filtrate was removed with MnO_2 as a collector. The combined filtrate was acidified and the hydroxides precipitated with NH_3 gas, avoiding an excess. The hydroxides were filtered, washed and dissolved in strong HCl. The acidity of the solution was adjusted to 6N in HCl and Ga removed by repeated extraction with ice-cold ether. Ether was removed from the combined ethereal extracts. The Ga was dissolved in dilute HCl. Requisite quantities of ammonium acetate, ammonium chloride and sodium fluoride were added and the pH was adjusted to 5. The colour produced with quinalizarine was matched against standards in a photo-electric colorimeter. The sensitivity of this method was found to be up to 1 γ per c.c. below which irregular results were obtained. Incidentally it may be mentioned that the same set of samples were analyzed for Ga spectroscopically by B. Mukherjea.[4] The results obtained by the two methods which are given below will be found to be practically concordant.

Bauxite No	Locality	Present chemical method % Ga.	Mukherjea's results % Ga.
291	Salgipat, N. Lohardaga, Bihar	·0017	·002
5038	1 mile N.W. of Dhagarvadi, Kolhapur, Bombay	·0023	·0026
797	Yelurgarh, Fort, Bombay	·00275	·003
788A	N.W. of Radhanagri	·00415	·0043
737	N.E. of Amarkantak, S. Rewah	·0033	·0035
4696	Katni, Jubbulpore, C. P.	·00565	·0055
1128	Surganj State	·0074	·007
1142	"	·0077	·008
5100	Salal, Riasi Tehsil, Kashmir	·0071	·007

Our best thanks are due to Mr B. Mukherjea for the qualitative spectrographic analyses for gallium in the residues left after alkali fusion.

A. MAJUMDAR
P. B. SARKAR

Laboratory of Ghose Professor of Chemistry,
University College of Science & Technology,
92, Upper Circular Road,
Calcutta, 13-6-1947.

[1] H. H. Williard and H. C. Fogg, *J. Am. Chem. Soc.*, *59*, 40, 1947.
[2] Lecoq de Boisbaudran, *Compt. rend.*, *82*, 1098, 1876; *83*, 636, 824, 1876; *93*, 815, 1881.
[3] D. C. Grahame and G. T. Seaborg, *J. Am. Chem. Soc.*, *60*, 2524, 1938.
[4] B. Mukherjea, SCIENCE AND CULTURE, *12*, 598, 1947.

NATIONAL HERBARIUM FOR INDIA

AT the Twenty-fifth (Silver Jubilee) session of the Indian Science Congress, a discussion was held on the subject of 'A National Herbarium for India' in the Botany section of the Congress held in cooperation with the Indian Botanical Society, in the presence of a large gathering of botanists of India and abroad.

A National Herbarium should contain a collection of plants fully representative of the species including all their varieties, etc., found within the country and include as many types and co-types of these as possible.

Such a collection is needed not only for the use of botanists but also for foresters and agriculturists. It is also needed for the preparation of provincial and local floras.

As a result of these discussions it was resolved that the nearest approach to a National Herbarium is the Herbarium located in the Royal Botanic Garden, Sibpur, which should be converted as such.

Unfortunately, very few of the earlier collections, on which the description of Indian plants are based, are now not available in India. They are to be found in various British and European herbaria, the most important of which are those of the Royal Botanic Gardens, Kew and the British Museum, London.

The causes which led to the transfer of these specimens need not be dilated here. In fact, it was not until July, 1937, and due to the initiative of Prof. B. Sahni, F.R.S., that special rules were framed for the loan, gift, or exchange of specimens from the Sibpur Herbarium. In the early days of the East India Company, duplicates were even distributed in several European herbaria but not in India. The most glaring instance of such an omission is the absence of a set of 'Wallichian Collections' in India.

Thus for more than a quarter and a century types of Indian plants found their way outside India, thereby seriously affecting botanical research in India, and to the detriment of the loss of India's cultural assets.

Recently, Maulana Abul Kalam Azad, introduced a bill in the Central Assembly, for the purpose of reclaiming Indian treasures taken out of the country during the last 200 years of British rule and stopping any further transfer of such specimens as are of educational and cultural treasures.

It may not have occurred to the sponsors of this proposal that these botanical specimens contained in the British Museum and the Royal Botanic Gardens, Kew are equally important National Treasures of educational and cultural value and they should be included in the list of inventories now being prepared by the Government of India for the recovery of Indian specimens from Britain.

It has been argued by the late Sir Arthur Hill (a former director, Royal Botanic Gardens, Kew) regarding these early collections made in the time of the East India Company's administration that "some were made by private individuals, others by servants of the Company in their private capacity, others by servants of the Company in their official capacity who were permitted by the directors to retain possession of them when they retired from their service, while others again were stored in the London offices of the East India Company and were finally handed over by the Court of Directors to Kew" . . . . .

"Those that are at Kew were therefore acquired by purchase or by deed of gift and there can be no question as to their present ownership ; nor can there be any question that they are in their rightful place, considering that they contain many type specimens on which the Indian Floras prepared at Kew are based".

Indian botanists, on the other hand, claim that these types or co-types have got to be re-acquired for the Sibpur Herbarium and the state of things as stated by Sir Arthur is not accurate. A number of expeditions were carried out during East India Company's regime and after and all these collections, mostly housed at Kew are not gifts or exchange.

The Government of India have now to take steps to draw a complete list of such collections and find out the exact position with regard to these and for this purpose it is necessary to appoint a committee, preferably a paid personnel, to draw up the list at once. Such a committee, should include a representative of each of the following organizations:

(1) National Institute of Sciences of India ; (2) Indian Botanical Society ; (3) Botanical Society of Bengal ; (4) A nominee of the Government of India, and (5) A nominee of the Government of Bengal.

This committee will have to go through carefully with the list of collections now in Great Britain and place facts before the Government of India within as short a time as possible, who would communicate their decision to the India Office, at London.

It has also to be borne in mind that the Government of India is maintaining many more herbaria other than the one at Sibpur, *viz.*,

(1) The Herbarium of the Forest Research Institute, Dehradun (Established 1816) ;

(2) The Herbarium of the Economic Botanist to the Government of Bombay (Established 1880) ;

(3) The Herbarium of the Government Museum, Madras (Established earlier than 1878) ;

(4) The Herbarium of the Imperial Mycologist, New Delhi.

The collections of all these herbaria have also found their way outside India. A list of such collections now in Britain also needs scrutiny.

It has been further brought to our notice that many of the early Indian collections did not reach Kew, because Kew was then not in existence. These collections found their way to the British Museum, Gray Herbarium, Herbarium at the Royal Botanic Garden, Edinburgh, etc.

The attention of the Government of India is drawn to these facts, as it is of so vital importance to India's botanical, agricultural and forestry developments. Now that the botanical survey is going to be revived, it is all the more necessary that Indian workers should get ready in their hands, the Indian collections. Without this, the survey will be greatly hampered in its work.

A. K. GHOSH

The Herbarium,
Calcutta University,
35, Ballygunj Circular Road,
Calcutta 19, 17-6-1947.

SALTATION IN *HELMINTHOSPORIUM ORYZAE* BR. DE HAAN

IN 1942, during the course of an investigation into the diseases of rice at Dacca, seven cultures (three grown on soil mixed with oatmeal in flasks, two on oatmeal agar in test tubes and two on oatmeal agar in petri dishes) were found to produce differentiated patches consisting of masses of pink compact hyphae which suggested contamination. Although the morphological characters were seen to agree closely with those of the original culture of *Helminthosporium oryzae*, two distinct differences were noticed in the new form of growth, *viz.*, pink colour of the mycelium and sterility. The new form was studied and was found to be quite distinct from the original. Since saltation in *Helminthosporium* is of frequent occurrence, it was suspected that this new sterile form may be a saltant of the parent form. Monosporal cultures of the fertile form and monohyphal cultures of the sterile form were studied and their pathogenicity was also tested.

Pinkish mycelial patches appeared scattered over the original mycelium. Matsura[1] observed the appearance of a saltant of this type in the *Helminthosporium* stage of *Ophiobolus miyabeanus* Ito et Kuribayashi, and designated it as Island type of saltation. In four cultures it was observed that the parent form consistently gave rise to the new form, while the latter only in two cultures produced the former (Orthogenetic saltation). In a few cultures, however, reversion was observed[2]. The number of patches producing the sterile form and the areas occupied by them increased as the parent cultures became older.

A. *Morphological characters.*—The parent form (*Helminthosporium oryzae*) is dark brown in colour and exhibits slow growth. Hyphae are fertile, measuring 1·35 to 3·85 μ in diameter, the average being 3·10 μ. The new form is pink in colour and exhibits copious aerial growth, and its mycelium is dense. Hyphae are sterile, measuring 1·83 to 7·57 μ in diameter, the average being 5·75 μ, with profuse branching and cells longer than those of the parent form.

B. *Parasitic activity.*—The under-noted varieties of *Aus* and *Aman* paddy were inoculated with the two forms of the fungus with a view to testing their pathogenicity:

Aus: *Kalaktara*, *Dular* and *Dharial*.

Aman: *Latisail*, *Indrasail* and *Bhasamanik*.

The methods of inoculation employed were as below:

(*a*) Inoculation of soil with cultures of the fungus grown for three weeks on soil mixed with oatmeal,

(*b*) Inoculation of leaves of healthy seedlings with the mycelium, and

(*c*) Inoculation of the collar region of healthy seedlings with the mycelium.

The results of inoculation tests are given in table I. Letters (*a*), (*b*) and (*c*) mentioned above have been used in the table indicating the methods of inoculation.

TABLE I

INOCULATION OF RICE SEEDLINGS WITH *H. oryzae* AND THE NEW FORM

Variety	Inoculum	Number of seedlings inoculated by different methods of inoculation			Number of seedlings infected by different methods of inoculation		
		(*a*)	(*b*)	(*c*)	(*a*)	(*b*)	(*c*)
Aus:							
Kalaktara	Parent form	6	6	5	5	3	5
	New sterile form	8	6	6	1	2	2
Dular	Parent form	6	6	6	3	2	4
	New sterile form	6	6	6	1	—	3
Dharial	Parent form	6	5	5	6	4	5
	New sterile form	6	6	6	1	—	2
Aman:							
Latisail	Parent form	6	6	8	4	3	5
	New sterile form	7	7	8	1	—	—
Indrasail	Parent form	7	8	7	5	5	4
	New sterile form	7	7	7	2	4	3
Bhasamanik	Parent form	5	5	5	5	3	4
	New sterile form	6	6	6	1	2	2

The table shows that the parent form of *H oryzae* is much more virulent than the sterile form.

Since considerable differences exist between the two forms in respect of their morphological characters and pathogenic activity, it is obvious that the

two forms are quite distinct and that the sterile form is a saltant of the original fungus.

The author is thankful to Dr P. Maheshwari, Head of the Department of Biology, Dacca University, for giving facilities to work in his laboratory, and to Dr S. N. Dasgupta of Lucknow University for examining the parent form and the saltant.

S. P. RAYCHAUDHURI

Division of Mycology and Plant Pathology,
Indian Agricultural Research Institute,
New Delhi, 24-6-1947.

*[1] Matsura, I., *J. Plant Protect.*, 17, 7, 1930.
[2] Dasgupta, S. N., Saltation in fungi, 83 pp., Lucknow University Studies, No. V, 1936.

* Original paper was not available, abstracts were seen in *Rev. appl. Mycology*.

BENZYL BENZOATE AS AN ADULTERANT OF OIL ANISI

SAMPLES of oil anisi recently received in this laboratory for analysis not only did not conform to B. P. Standards but were actually found to possess high specific gravity. It has been mentioned[1] that genuine oil anisi sometimes becomes heavier than water on prolonged exposure to light and air. With a view, therefore, to find out if these samples were such specimen of oil anisi, their detailed examination was undertaken. On subjecting them to steam distillation, about 5 per cent genuine oil anisi of B. P. quality was recovered from the steam distillate. The non-volatile portion (approximately 95 per cent) was identified as benzyl benzoate ($C_6H_5.COOCH_2.C_6H_5$).

The use of benzyl benzoate as a fixative for most floral perfumes has been recorded[2]. But I have not come across any reference recording its use for the adulteration of oil anisi.

S. C. ROY

Public Analyst's Laboratory,
Government of United Provinces,
Lucknow, 25-6-1947.

[1] Gildmeister and Hoffman, *Volatile Oils*, 3, 344, 1922.
[2] Allen, Commercial Organic Analysis (5th Edition), 4, 575.

VACANCIES FOR SCIENTIFIC WORKERS

1. ASSISTANT AGRICULTURAL CHEMIST, New Delhi: Salary Rs. 200-15-350-20-650. Qualifications: (*a*) M.Sc. or diploma of I.A.R.I. in Chemistry, (*b*) Post-Graduate training in Agricultural Chemistry or Soil Science or in Analytical Chemistry and (*c*) Good record of research work for about 5 years. Age: preferably below 35 years (38 years for Scheduled Caste candidates). Apply before 23rd August, 1947 to Secretary, Federal Public Service Commission, Simla.

2. ASSISTANT MINOR FOREST PRODUCTS OFFICER, Dehra Dun: Salary Rs. 200-15-320-20-600. Qualifications: (1) M.Sc. or higher degree in Botany, with Chemistry as one of the subjects in B.Sc.; (2) Training in Systematic or Economic Botany; (3) Knowledge of vegetable economic products of India; (4) Some experience in the study of anatomy of plants; (5) Knowledge of the system of collection and marketing of minor forest products; (6) Field experience in botanical and economic surveys; (7) Ability to write English in lucid style. Age: maximum 35 years (38 years for Scheduled Caste candidates). Apply before 23rd August, 1947, to Secretary, Federal Public Service Commission, Simla.

SCIENCE AND CULTURE

A MONTHLY JOURNAL CONDUCTED UNDER THE GUIDANCE OF THE

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SCIENCE AND CULTURE

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NATIONAL FIBRE RESEARCH INSTITUTE IN INDIA

WITH the new political set up resulting in the division of India into two independent sovereign States and the partition of Bengal and Punjab Provinces, the assets and liabilities of the Central Government have also to be divided. The problem of adjustment of India's economies with the new situation has suddenly become very acute and engaging the attention of prominent men of the country. We on our part are mainly concerned with the future of the scientific services, research institutions, museums and herbaria and other scientific organizations now constituted on an all-India basis. Fortunately, most of these are included in the Indian Union and the partition, though it may affect them to some extent, will hardly interfere with their activities. But a piquant situation has now arisen in respect of the Indian Central Jute Committee, because its institutions are equally divided between the two areas. Further, though about 75 per cent of the jute is grown in the Pakistan area, cent per cent of the factories which turn raw jute into finished products are in the Indian Union. What will be the future of the jute industry and the jute research under such conditions of artificial partition?

This is a very important economic problem, because the future of the country depends on the continued production, processing and use of essential minerals and agricultural products. Now of all the fibres of India, jute is commercially by far the most important. India on an average produces about 6 million bales of cotton but about 9 million bales of jute (1 Bale = 400 lbs. = 5 mds.) per year. The value of the total production of raw jute in a normal year is nearly 100 crores of rupees. The value of the processed materials which consume nearly 60 per cent of the raw product amounts to more than 100 crores of rupees. Jute is practically the only money crop in major parts of Bengal and besides enabling the rural population to buy necessities of life other than food, it gives employment to about 3 lakhs of industrial workers. Besides, the value derived from the excise on jute and jute goods used to form a substantial part of the incomes of the Indian Union as well as of the Government of Bengal. Jute is also grown on a fairly extensive scale in some districts of Assam, Bihar, U.P. and Orissa. So this concerns not only West Bengal but also other provinces of the Indian Union. It is, therefore, worthwhile to survey the position critically and forecast the problems which may arise out of the partition with a view to finding a suitable solution.

HISTORY OF JUTE TRADE

Although cultivation of jute in India has been carried on from a remote period, the export of jute started in 1793 and that of jute gunnies and packing cloth in considerable quantities commenced from 1828. Jute fibre was then handspun and handwoven and a particular caste arose out of jute weavers. During these times, gunnies, however, used to be made from other fibres as well, and those exported from the Ganjam and Vizagapatam coasts were in all probability from *Hibiscus Cannabinus* (*Mesta* or Deccan Hemp or Bimlipatam jute). Export of raw jute was firmly established about the year 1838 and since then, trade in raw jute increased rapidly. The Crimean War gave it a strong impetus as it put a stop to the import of Russian flax and demand for jute considerably increased. Jute spinning and jute weaving by machineries and in factories first started in Dundee about 1836, the flax machineries being used for the purpose. Dundee was a big whaling centre, and as whale oil was found suitable for softening jute fibre so as to make them amenable for spinning, somehow the factories began to grow about Dundee. It was Scotchmen from Dundee who brought jute manufacture to the banks of the Ganges, where the first jute mill was started in 1855

at Rishra, 20 miles upstream of Calcutta. The industry grew rapidly about Calcutta on account of the unique combination of easy availability of raw materials, coal, banking, trade, labour and export facilities. The pioneers, and for a long time also monopolists in the jute industry, have been Scotchmen, and though at present they no longer hold the monopoly, the major interests in jute industry are still held by them.

Since then the record of jute industry in India has been one of almost uninterrupted progress. During the World War I and afterwards, the industry enjoyed unparalleled prosperity. While the chief products of the mills in the pre-war times had been gunnies and hessian cloth, military demands during the last war gave an impetus to the conversion of the latter into sandbags, 'pre-fabricated bituminous surface' for aerodromes, jute canvas, etc.

Though we have heard from time to time of substitutes for jute, the greatest recommendation of jute has always been its cheapness and possibility of large-scale production. The demand of jute in the world's market is based upon the fact that no cheaper fibre is yet procurable for bagging agricultural and certain mineral products. It is not known how long India will enjoy this monopoly but since experiments on finding substitutes for jute are being made in other parts of the world and jute has been successfully grown in the Amazon Basin, Egypt, Formosa, China, etc., and attempts are being made to grow it in Turkey, U.S.S.R. and the British possessions of Africa, neither the Indian Union nor the Pakistan Government can ignore the possibility that jute may be largely ousted from the world market in near future.*

Beginnings of Scientific Research on Jute

The demand for an investigation into the possibility of improving the yield and quality, so that jute might not encroach on the area under food crops arose quite naturally. Mr Hem Chandra Kar of the Bengal Civil Service was appointed in 1872 to compile a report on "The Cultivation of, and trade in, jute in Bengal" and a comprehensive volume was submitted two years later. This may be taken as the starting point of surveying the position of jute. Defective methods in cultivation, retting and other cognate matters were again represented by the Calcutta Baled Jute Association in 1901 and they asked the Government that the Agriculture Department should examine whether the cultivation and yield of jute could be improved.

The subject was later discussed by the Board of Scientific Advice to the Government of India and Mr R. S. Finlow was appointed Jute Expert in 1905 and later designated as Fibre Expert to the Government of Bengal. This post is still retained by the Government of Bengal, but the fibre expert carries on investigation on fibres other than jute.

In 1905, Mr Finlow made an extensive tour throughout India to explore the possibilities of extending the cultivation of jute or similar fibres in tracts outside Bengal. Experimental trials carried out revealed that successful cultivation of jute could be possible in Assam, North Bihar, and even in the Punjab (provided suitable retting facilities were found).

Research on the production of jute was thereafter continued by the provincial agricultural departments for nearly a quarter of a century. Finlow and Burkill carried out considerable experiments on pure line selection, hybridization, manurial experiments and effected improvements in cultivation and distribution of improved seed.

Indian Central Jute Committee

The Royal Commission on Agriculture in India, for the first time in 1927, recommended the formation of an Indian Central Jute Committee on the lines of the Indian Central Cotton Committee established in 1923 which would "watch over the interest of all branches of the trade from the field to the factory". The recommendations were accepted by the Government but the Committee was not constituted until 1936.

The functions of this Committee has been to undertake agricultural, technological and economic research, the improvement of crop forecasting and statistics, the production, testing and distribution of improved seeds, enquiries and recommendations relating to banking and transport facilities and transport routes and the improvement of marketing in the interests of the jute industry in India.

The Government of India financed the Committee by an annual grant of Rs. 5 lakhs from Central Revenues. The Committee established two centres for jute research, *viz.*, (1) Technological Research at Calcutta and (2) Agricultural Research at Dacca. Industrial Research is also being done by the Indian Jute Mills Association Research Institute* in Calcutta.

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* The most formidable competitor of jute at present is Kraft paper and various products made therefrom. Roselle in Java is a real menace, softened sisal in Africa is another. 'Fibro', a rayon, is being successfully woven on jute machinery in U. K., cheap production of Fibro has been assured by a leading firm of England.

* The Indian Jute Mills Association was constituted in 1884 and the membership of the association is about 60. The objects of the association include financing technical developments in plant and machinery for the manufacture of jute and its products and scientific exploration of new uses to which jute can be applied and the discovery of by-products. Their research institute is comparatively smaller

The two institutions under I. C. J. C. have carried out important investigations for nearly a decade. Some new strains have been evolved that appear to be superior to the existing ones of the agriculture department of the Government of Bengal. Improved cultural methods, effective control measures to combat diseases and pests and improved methods of retting have been worked out. These investigations have resulted in increasing the yield and quality of the fibre and the new strains are now being tried in farms. The quality of fibre is tested at the Technological Laboratory where important researches on the fundamental aspect has been done. For example, assessment of quality from measurable physical and chemical characters of the fibre has made considerable progress; it is now possible to define quality in definite terms. A technique of spinning from as small as 10 lbs. of fibre has been developed. The cause, and a simple method of removal, of colour of *shamla* jute have been discovered. Improvement of jute bags as container of sugar in humid atmosphere by chemical treatment now seems possible. The fundamental chemical properties of the fibres, so long vaguely known, have been studied with considerable success and the results have won international recognition. But the results so far obtained are not enough, for due to war the activities of the laboratory could not be expanded. The Reorganization Committee under the chairmanship of Prof. M. N. Saha has recommended expansion of research activities on a far more generous scale, including X-ray and optical examination of fibres, investigation of the dyeing, bleaching and finishing processes of the fibre and yarns, the associated chemistry of high polymers, including the colloidal, and recommended further that a weaving section should be started and a programme should be drawn for investigation of machinery used for jute spinning, weaving and finishing, and for finding out processes for new uses of jute, *e.g.*, for making blankets, semiwoollen wrapper, union fabrics, etc.

The Government of India have thus invested a certain amount of money,* by no means large compared to the income which jute brings to the Central and Provincial exchequers, for jute research and valuable results have been obtained. It is imperative that the continuity of the research work is maintained, otherwise the results so far obtained will be of no practical use. A fairly large number of pure line materials are now maintained by the Jute Agricultural Research Laboratory. These have been obtained by years of research work.

(having no experimental spinning section for testing quality of fibres); the results of the institute cannot be available to the public and so their exploitation by outsiders or Government for the good of the country does not arise.

* The total money value of raw jute, and products of jute is nearly 150 crores of rupees. According to the standard laid down in U. S. A. and U. K., 1 per cent, *i.e.*, 1·5 crores should be annually spent on research. The expenditure so far has been only a meagre sum of 5 lakhs per year.

The Future of Jute

A peculiar situation may now arise if Pakistan prefers to export directly more and more raw jute outside India and jute mills remain where they are now. The Government of Indian Union will then have to produce more jute to feed these mills in order to avoid a crisis. Since one maund of jute at present buys three maunds of wheat from abroad, and even if all the land under jute be put under cereals, we cannot meet even one-tenth of our deficit of foodstuff, it is apparently more profitable to grow more jute. The yield and quality of the fibre must be improved appreciably, and this can only be done by agricultural research. Agricultural and technological research must go hand in hand, for assessment of quality is done in the technological laboratory. Furthermore, we have to find new uses of jute so that India may herself consume more of it, if not the outside world, in case jute competitors tend to oust it from the world market for gunny bags. Well-planned and well-executed technological research is indispensable for this purpose. Then again, there are other important long fibres (similar to jute in many respects) in India, such as sunn hemp (*Crotolaria juncea*), Deccan hemp (*Hibiscus cannabinus*), etc., the cultivation of which may be encouraged to meet the shortage of jute. Other long fibres, *e.g.*, flax (*Linum usitalissimum*), sisal (*Agave sisalana*), true hemp (*Cannabis sativa*), ramie (*Boehmeria nivea*), etc., which are also grown in different parts of India, have so far been neglected. For national economy this is hardly desirable; these may very well be studied in all aspects in the proposed 'National Fibre Research Institute'. It may be mentioned here that Dr W. Burns in his memorandum entitled "Technological possibilities of Agricultural development in India (1945)" recommends the establishment of such an institute.

We are, therefore, of the opinion that for the best interest of India, as a whole, including both the territories of the Indian Union and Pakistan, not only the activities of Indian Central Jute Committee should be continued unhampered but also these must be considerably expanded without delay in the light of the recommendations of the Reorganization Committee with the ultimate object of converting it into a Long Fibre National Research Institute. Scientific research on fibres and other cellulosic materials has engaged the attention of all advanced countries and the Textile Institute of England, the Textile Research Institute of U.S.A., the Paper & Pulp Research Institute of Canada, are good examples. This hardly depends on the quali-

tity of commodity produced but on its importance to the nation as a whole. Thus England efficiently maintains a number of research organizations for commodities of which she produces only a negligible quantity or none at all. Examples are the Shirley Institute near Manchester for research on cotton, the Linen Industry Research Association Laboratory at Lambeg, in N. Ireland for flax, the Technological Research Institute at Dundee for jute, the Imperial Institute of London for agricultural and mineral products, etc. There is no reason, therefore, why India should lag behind in matters of scientific research on such a vital crop if she really wants to solve her economic problems.

Grants in U.K. for Textile Technological Training

The board of Courtaulds, Limited, announces that the company has decided to make grants totalling £140,000 to the following sixteen technical colleges and institutions:

Bradford Technical College, £30,000; Bolton Municipal Tech. Coll., £30,000; Nottingham and District Tech. Coll., £20,000; Blackburn Municipal Tech. Coll., £10,000; Leicester College of Technology and Commerce, £10,000; Huddersfield Tech. Coll., £5,000; Preston—The Harris Institute, £4,000; Glasgow—The Royal Tech. College, £4,000; Burnley Municipal Tech. Coll., £3,000; Keighley Tech. Coll., £3,000; Coventry Municipal Tech. Coll., £3,000; Halifax Municipal Tech. Coll., £3,000; Nelson Municipal Tech. Coll. and Art School, £3,000; Oldham Tech. Coll., £8,000; Belfast College of Technology, £8,000; Dundee Institute of Art and Technology, £5,000.

The object is to encourage the development and expansion of textile technological training in subjects of importance to the British rayon industry.

SEEKING SNOW IN THE HIMALAYA ("HOME OF SNOW")

J. E. CHURCH,

ADVISER, HIMALAYA SNOW PROJECT, CENTRAL WATERWAYS, IRRIGATION AND NAVIGATION COMMISSION, NEW DELHI

THE Indians like their Russian neighbours have expressed a desire to know how my life has become synonymous with snow and how some of my friends address me as Dr Snow and the letters are correctly delivered to me.

It is a strange story only half a century old but it leads directly from the mountains of the American West to the heart of the Himalaya from which I have just returned (See SCIENCE & CULTURE, 12, p. 570). I have written a series of articles called the Human Side of Snow, *e.g.*, (*i*) Saga of Mount Rose Observatory, (*ii*) Snow Sport and Transport, (*iii*) Perennial Snow and Glaciers, (*iv*) Snow Perils and Avalanches. I would like now to write (*v*) The Birth and Wanderings of an Iceberg, and (*vi*) Snow-Surveying in the Himalaya.

I was trained to teach classics and knew only the unpleasant things about snow. But I went to teach in the great American Desert because my room mate at the University of Michigan said I was a fool if I didn't.

Here at Reno, I found my Mount Rose 10,800 ft. high which I was destined in future to climb 150 times. Then finally I forgot to count. The first time I climbed it to get acquainted. The second time I delayed until the mountain was white with snow, when a sneer forced me to action. It was the last day of December before we started and the snow came to the hubs of our cart as we reached the base of the mountain. We had only one pair of snowshoes in Reno for the two of us and we were obliged to draw stockings over our shoes with ordinary rubbers outside. Luckily the snow as we toiled upward became hard by having been blown by the wind. We could only peep for a moment into the cold over the summit and fled down the slope where we warmed our feet by thrusting them beneath the snow. The town paper acclaimed us as the first white men to climb Mount Rose in winter but the University student paper said that "Church and Allison spent the weekened snow-shoeing around the base of Mount Rose". Unfortunately we had taken no pictures.

I could never refuse a dare and the angels must have smiled in pity at my ignorance of perils, for I was generally successful. Mrs Church and I slid down Mt. Shasta, one of the highest peaks of the United States, on a series of incipient avalanches that we started to accelerate our descent. We spent two years at the University of Munich among the

Bavarian Alps, then returned to Reno to spend our Christmas vacation on the snow at the crest of the Sierra, where each night we set fire to a dead tree as a messenger like a faint star to our home in Reno that we were still alive.

Then to startle the Californians into a realization that snow would not hurt their feet, two of us in February spent a week climbing up Mt. Whitney, the tallest mountain in the United States, to 13,300 ft. where a broad crack opened in the new snow just above us and a stone rolled by my foot from the cliff where we stood boomed so faintly in the depths that it made me seasick. In my diary I wrote "The call of the wild is strong but the home call is stronger".

The U. S. Weather Bureau had left a thermometer on Mount Ritter all winter to obtain the minimum temperature there. So I offered to climb Mount Rose once a month for a year to obtain the temperature records.

Dr J. E. Church

Thus the door to five and one half decades of snow experience was opened to me.

A tiny weather observatory 7-feet cube was ultimately nestled in the rocks at the very summit of Mt. Rose where we lived in comfort in gales that blew 70 miles per hour for an entire day continuously and we could stand with our feet in the funnel end of the plumes of snow like those that often wave from the peaks of the Himalaya.

It was a paradise for studying the effect of mountains and forests on the conservation of snow, and out of this study came the long snow courses laid across the slope of the mountain and the measurement of the water equivalent of the snow by long snow-sampler tubes that finally could penetrate snow of 20 to 30 feet in depth. The snow was thus measured in terms of its potential water as well as its depth, for the users of water and power were the greatest users of snow and must know exactly what to expect. The depth of snow was valuable mainly if you had to shovel it out of the road.

Meantime just behind Mt. Rose, Lake Tahoe, called the most beautiful lake on earth, was becoming flooded by high water and the angry residents were threatening to blow out the dam unless power company would agree to draw the level of the lake far down every autumn. If a winter proved to be dry, this would mean bitter loss for the people downstream.

So an appeal for some means of forecasting the annual rise of the lake was made to me. Fortunately Lake Tahoe was a snowfed lake and must rise according to the amount of water in the snow. The present season the snow courses on Mt. Rose showed twice as much water as the previous year. So Lake Tahoe should rise this year twice as high. Thus forecasting from snow-surveys was born and was called the Nevada or percentage system and in honour of Mt. Rose the sampler was named the 'Mount Rose Snow Sampler'.

The idea of forecasting streamflow grew until all of the neighbouring States have snow survey systems and the city of Los Angeles adopted it for its great aqueduct from the highest part of the High Sierra.

Then the Congress of the United States in 1936, authorized the U. S. Division of Irrigation to create the Federal-State Cooperative Snow Surveys and now throughout the mountain areas of the United States and Canada, scores of streams are surveyed by hundreds of snow surveyors each winter and on the great Columbia and Colorado Rivers, at Portland, Oregon and Los Angeles, California, forecasters' meetings are held each April to discuss the outlook for water and power during the coming summer.

So accurate have the snow surveys become that on the Colorado River, the rise of Lake Mead at Boulder Dam can be forecasted on May 1, within 15 per cent of normal for the months of April-July, the period of snowmelt. The accuracy expected on most streams on April 1 is within 10 per cent.

In 1926-28 three summers and one winter were spent with the Michigan-Greenland Expedition among the glaciers of Greenland and one winter was spent in a tent on the Inland Ice with only two heating lamps in a minimum temperature of −44°F. We were three—a Dane, one Eskimo, and myself—in the great immensity, watching the clouds and the

snow. I felt humble but grateful and proud to Nature for letting me stay and share in its endlessness.

In 1930 I was asked to organize the Committee on Snow of the American Geophysical Union but almost immediately because Australia wished to join and the Committee was American only, the International Commission of Snow was organized by the International Union of Geophysics so that all countries could join. And because snow surveying would be its chief feature, I was made its president. It is now the *International Commission of Snow and Glaciers*. About 300 members are in it with a large group from India. It gives us deep friendships in now.

Escapades cannot be escaped at the provocation to retreat. In 1944 a Mount Rose colleague, S. P. Fergusson of the Blue Hill Meteorological Observatory, Boston and I, in our high seventies, climbed far up Mount Washington, the roughest mountain in the United States, to prove that snow will freeze when the temperature of the air 4 ft. above it is still 40°F. We had climbed so far that we decided to climb to the top, up the almost vertical slope of Tuckerman's Ravine and spend the night at the radio station there.

Blue Hill was amazed at hearing our voice over the radio phone. We were 6,290 ft. above the sea and had climbed more than a mile vertically that day.

1945 was a startling year. In 1936, I had fallen ill with double pneumonia in Moscow and been nursed slowly back to health in a Russian hospital without the charge of a single kopek, the cashier briefly saying "The Hospital does not keep books with its patients. There is nothing to pay". I had even been offered the opportunity to go without cost to a sanitarium in the Crimea until I was "entirely sound". Now suddenly in 1945 I received an urgent telegram inviting me to be one of 40 American scientists at the 220th Anniversary of the Soviet Academy of Sciences with all expenses paid.

At Teheran, we met Prof. Meghnad Saha of Calcutta University, one of the 130 guests who were assembling in Moscow and were present at the great pageant celebrating the downfall of Hitler.

I am not alergic to Moscow but was ill once more from canteloupe eaten in Cairo. But I was able to attend the first banquet. I sat down alone at the corner of Table II and the elder daughter of Madame Curie sat in the middle. Across from me sat three Russian scientists gaily chatting.

At first they smiled at me. Then they smiled to me. One said, "Name please" and I answered, "Church, snow and ice". Then he said, "I can speak a little English" and I replied, "And I can't speak any Russian". Then one of the three left the table. I thought that he had sought chattier company and expected that the others would follow him. But in a few moments he returned with a young woman, an interpreter, named Marina.

Without hesitation as if she knew their thoughts she began: "You know we Russians are curious. We would like to know what courses you have had in snow and ice and what degrees". I shook my head, saying "I haven't any". They looked so disappointed and disillusioned. But I continued steadily, "Furthermore I have been a teacher of classics all my life and hope to see an art gallery at our University before I die".

There was a sudden clapp of delight from Marina, who exclaimed "O you are a Leonardo da Vinci", (the Italian renaissance artist and scientist) and the faces of the group brightened with understanding and delight. My stock spiraled upward and has never come down. Marina was the first woman and Russia the first nation to understand my dualism. She became my companion during my 18 days in Russia and helped me collect a new snow group of Russian scientists, for my brilliant array of 1936 had starved to death in the 18 months seige of Leningrad.

In 26 days I was home again from a trip around the world via Siberia and Alaska and past its towering peak of Mt. McKinley.

I wrote Fergusson of Blue Hill, "What next? The Moon?" I did not realize that my Moon lay closer to the Earth. "Could I transplant my snow survey system to the Himalaya", the highest mountain on Earth? Prof. Saha and Dr Banerji and Rai Bahadur Khosla had dreamed it and now asked the question. Could I bring the dream to pass? This would be the consummation of a life's work. It would bring honour to Mt. Rose. Better still, its service would be great.

But there were no pictures of the winter Himalaya and for measurements of either snow or streams. Reports of snow depths were conflicting or even fantastic. The trip was a "scientific adventure" with emphasis on both words.

To include the Yangtze we tried to fly up that river but finally flew over the clouds of China from Shanghai to Canton, to Hongkong to Kunming before the clouds dissipated and we would fly over the Himalaya Hump as in a glass-bottom boat looking upon the terraced peaks of Burma and Assam.

No snow was there and rarely ever had been. "The white mountain lay west".

The presence of the great water and power projects on the Kosi (40,000,000 acre ft.) and Teesta had turned all thoughts from Kashmir and the west

where snow abounds to the far southeast where the Himalaya hugs the heat equator and the winter snowline retreat far upward toward the peaks.

Three comprehensive programmes had been prepared and flights along the face of the range to trace the snowline had been proposed. The trek in Nepal led by Mr. J. Banerji became a search on foot of over 200 miles for damsites, glaciers and passes. Relatively deep snow was found in late March but it was rapidly melting.

The excursion on horseback in Sikkim was expanded to three trips in order to follow the trade and scenic routes that provide access to this greatest of 'National Parks' in the world. The Tibetans inevitably have possessed it for the Himalaya rise sheer from the India plain and only Tibetans could have come down from the Tibetan plateau with their yaks until trails upward were hewn through the impenetrable jungles and cut along the face of the cliffs. Rhododendron and magnolia trees color the mountain sides and orchids grow in clusters.

Sikkim is a land of peace and Gangtok like the Scotch Highlands is guarded against tourist commercialism. Dr Fleming, General Secretary of the American Geophysical Union, suggested when I went to Russia that I should be a messenger of international good will as well as a scientist. I wonder whether the Maharajah was not over convinced of my intentions.

For me I had arrived quite without permission, and without previous notice, a spitfire plane could be heard through the clouds photographing the mountaintops. But we were graciously granted permission to call before our party set forth on the Lhasa trail.

The Residence of the Political Officer and the Palace of the Maharajah are situated at the head of winding walks on the two hills of Gangtok. The latter has the simplicity and quiet beauty of an art gallery.

The children joined our procession and two little boys, met the evening before, clasped my hands for company. I immediately proposed that they should meet their Maharajah and drew them past the royal son and the prime minister in the portico and led them to the Maharajah to sit by me in audience with the other members of our party. I wanted him to know that I liked his little boys.

What we did not realize is that he did not like firearms loose in his country and we had brought our wireless contingent like an invading army before him with sten guns hanging from their shoulders.

His Majesty with perfect poise inquired about snow surveying and I explained the purpose of our trip. But we had not proceeded far up our trail before a peremptory message from the Political Officer demanded that the guns be surrendered to the Sikkim police. I wrote a note to the Maharajah explaining my ignorance and expressing a hearty hope that he would not release the guns until we had crossed his boundary.

We climbed the heights seeking snow, I on my pony looking like the Lama in Kipling's Kim with a host of attendant Kims in my train. My fame must have preceded me, for an ancient Tibetan priest saluted me on the trail saying "Himalaya, *Salaam*".

Sugar cubes had been our gift of friendship in Greenland. So when I left America, candy was given me by my Danish Greenland friend Pippa Phillips for children in the Himalaya. I did not expect to find any in these "wilds" but our tour became an endless succession of stops to surprise little tots and grown-old grandmothers with a smile and a bit of candy. The original candy had to be replenished many times. Ultimately we reached at least the women and the children among our own porters and the members of our staff.

The snow was fast melting. In May it did not freeze even at night at 13,000 ft., but the streams were snowfed. They rose and fell each day and day by day grew deeper as the snow-line rose higher. But there was a wealth of snow. Even in mid-May when our expedition followed the long tourist ridge between Nepal and Sikkim, the towering masses of the Mount Everest and Kanchenjunga ranges, that feed the Kosi and the Teesta, looked more like marble than snow in their whiteness.

The Church Boys

Yes, there was snow and manpower too. A group of professional snow-assistants had volunteered to learn snow-surveying. They called themselves "the Church Boys". In my long teaching I had accumulated a foster family of 25 or more. Now a special group had banded together like our American Marines or "Neverfails" asking to be called my "Great Grandsons" for none of them was more than 25 years old.

On the far trip up the Teesta to the yak pastures where snow courses could best be laid out, they had swam in glacier streams and the youngest had gone into a swollen torrent alone to bring in a stake with a valuable record.

Another season, a snow-survey system must be adapted to the triple Kosi Basin of Nepal and successively United Provinces, Punjab and Kashmir must be included. Here the snow is lower and deeper and accessible to the *Sno-Cat* that can carry snow-surveyors far toward the sources of the Indus,

Brahmaputra and the Sutlej where pioneer work has already been done.

Some day the helicopter will be improved from its present ceiling of 8,000 ft. to 20,000 ft. and small snow survey parties will flit in the plane from course to course like a humming bird on its duties. The untattered condition of the prayer-flags fluttering the winter through all 15,000 ft. indicates the relative mildness of the wind where most of the landings would be made.

To knit the Himalayan States into close unity in measuring the snow and forecasting the streams, the system should be called the "Himalaya Co-operative Snow Surveys" and the various courses should be so marked.

The expeditions sent out the present year included foresters, botanists, geologists, medical aids, geographers, radio operators, camera men, hydrologists, snow surveyors, guides, commissary, pony men and women. The group suggested the Crusades but everyone had his duty.

In Sikkim the route covered 350 miles. I was happy to have ridden wherever the pony could cling to the rocks, but pondered the problem of shifting my saddle to a yak.

To one, John Hendry, in particular, tribute should be paid as poet laureate. He had been my companion on the Greenland glaciers 20 years ago and longed to renew friendship once more. He radiated cheerfulness.

The season had been dry, the snow elusive. But as we disbanded he read the following on "Snow, White Snow" in anticipation of snowier years to come. In my turn, I read it now to you as a tribute to an old India friend.

WHITE SNOW

"Snow, white snow
Where is it I should like to know
For we have travelled rather far
Not to gaze at Sun or Star
But Snow—White Snow.

"Banerji has grown a beard
Because of snow, white snow he feared.
Rain we have had and sleet and hail
Rocks and boulders, hell's own trail.
But as now homeward we do go
We ask where is the Snow, white snow.

"Bhur, Kabraji, all look sad
Because they feel they have been had,
But Church is as joyful as can be.
Snow fields for future does he see.
So let this for us sufficient be
For in months to come on all the ground
Snow, white snow will then be found".

C. A. John Hendry

INDUSTRIAL UTILIZATION OF ATOMIC POWER IN INDIA

In an article published in Science and Culture a couple of years ago, attention was drawn to the desirability of supplementing the fuel resources of India by more direct methods of harnessing solar energy.

The existing world resources in coal and mineral oil, it was pointed out, were the result of utilization of solar energy by the photosynthetic activity of green plants growing in earlier geological ages, which has been stored as transformed plant and animal remains. It was suggested that in view of the impending exhaustion of these fuel resources, more atention should be given to the cultivation of land and sea vegetations, and of their utilization as sources of fuel and power, and also for the development of methods of transformation of solar radiation to electricity, by means of photoelectric cells with high efficiency of transformation. Since the article was written, the dropping of atomic bombs on two Japanese cities has revealed the possibility of utilizing atomic energy for generation of useful power. It is interesting to note that in utilizing atomic power, man is using the same process as is used in the sun, for the apparently inexhaustable production of radiant energy.

Leaving aside the question of utilization of nuclear fission for military purposes, in which we are not interested and whose logical pursuit by the rival power groups will mean the destruction of the present form of civilization, we propose in the present article to discuss the question how far atomic energy can be utilized for industrial purposes, what will be the

economics of using of atomic fuel as compared to those of using coal and oil, and what are the world resources in fissionable metals compared to the known resources in coal and oil. We shall then use the information so gathered to discuss the feasibility of using atomic energy for industrial purposes in India. The reason for this enquiry is well known. India's resources in coal, so far as is known at present, is limited. There is a consensus of opinion amongst experts, that the available high grade coal seams should be reserved for metallurgical purposes only. Our known oil resources are also negligible, and we have to depend mainly on foreign supplies to meet our ever increasing requirements in oil. Our utilization of hydroelectric power is increasing, but there is a limit to our water power resources, and there are wide tracts including desert areas, where water power is not available.

On the other hand India has a potential source of atomic power in the rich and extensive deposits of thorium containing monazite sands, principally in Travancore, but also in the east coast districts of Madras, in Tinneveli and Waltair. Estimates of the total quantity of such deposits vary widely, as well of their contents of Thorium. As a mean of different estimates we can take it to be 3 to 4 million tons, with an average thorium content of 8 to 10 per cent.

Nuclear fission.—As introduction to the subject of atomic energy, we shall begin with a short account of the nuclear fission process, how the energy is released during fission, and of the principle of atomic reactor. As is well known, each atom consists of an inner dense core, the nucleus and an outer distribution of electrons, in a volume large compared to the dimension of the nucleus. The nucleus is made up of a chemical combination of two kinds of fundamental particles, protons and neutrons, which are approximately of the same mass; while the proton carries a unit of positive charge, the neutron is uncharged. The force of attraction between the nuclear particles, like the gravitational attraction and unlike ordinary chemical forces, is not of electrical origin; it only acts at extremely short distances, of the order of 10^{-13} cm. which is the order of nuclear diameter. The atomic diameter on the other hand is of the order of 10^{-8} cm. A nucleus is characterised by the total number A of nucleons (neutrons and protons) contained in it, of which Z are protons. In an atom with nuclear charge Z, there are Z outer electrons, which go to make the atom neutral. Thus the chemical properties of an atom depend upon Z, which is called the atomic number. Coal and oil which are used for fuel purposes are made up of carbon and hydrogen atoms, which can, under special conditions, be made to combine with oxygen to produce carbon dioxide and water. A large amount of chemical potential energy is released during such a process, and appears as heat, which can be used to drive heat engines to produce mechanical and electrical power. During a chemical combination there is a rearrangement of the outer valency electrons of the combining atoms, which go to form a common shell round the two nuclei with their inner electron shells. The energy released during such combination, as will be shown, is small compared to that involved in a nuclear combination. But in each case the principle of equivalence of mass and energy, first clearly enunciated by Einstein holds, *viz.*, that interaction between particles involving release of energy is always accompanied by a loss of mass Δ M of the interacting particles, such that if W is the amount of energy released, then $W = \Delta M. c^2$ where c is the velocity of light. For example one pound of the 235 isotope of Uranium during fission will give up as much heat as the combustion of 1500 tons of coals. The chemical energy released during combustion is so small that it does not produce any measurable change in the total mass of the reacting particles, while the 1 lb. of U 235 looses one part in thousand of its weight. This gives us an idea of the order of magnitude of energy changes involved in atomic and nuclear reactions.

Bethe has shown that the energy of stars, including the sun, is produced by the combination, in their hot interior, of the fundamental particles protons and neutrons into heavier nuclei like deuteron (containing one proton and one neutron) and helium nucleus (containing two protons and two neutrons). The difference in the sum of the masses of the combining particles before and after combination is proportional to the energy released. We are justified in saying that the stellar temperature, in spite of loss of energy by intense radiation, is kept up by the nuclear fire maintained at the core of each star.

The energy of fission, which is utilized in atomic piles, depends not on the synthesis, but on the break down of the unstable nuclei of heavy atoms at the end of the periodic table, like uranium and thorium, following their combinations with neutrons. The latter being uncharged, can very easily enter in to the nuclei of different atoms; the energy released by such nuclear combinations find expression as gamma-radiation or by the emission of electrons neutrons and other charged light particles. The maximum release of energy however takes place when the uranium nucleus breaks up into two particles of comparable masses, *e.g.*, Barium and Krypton which fly apart, due to electrical repulsion between the charges on the fission particles. It is found that the sum of the masses of the particles into which an excited Uranium nuclear breaks up is less by one part in thousand than that of the parent nucleus and hence this process is accompanied by large release of energy.

Uranium atom, which carries a positive charge Z=92, has two principal isotopes with A=235 and 238. Bohr predicted from theoretical considerations, that it is the lighter nucleus 235, present as 1 part in 138 in Uranium metal, which breaks up under absorption of both slow and fast neutrons. The 238 isotope can absorp neutrons of intermediate velocity without fission; the combined nucleus so formed does not break up, but behaves as a radioactive element which after successive emission of two electrons, gives rise to a new atom Plutonium (A=239, Z=94) which is fissionable under further neutron absorption. Thorium (A=232, Z=90) can also be made to break up under fast neutron absorption, at a very slow rate, and in addition can also give rise to an isotope of the element Uranium (A=233, Z=92) with fissionable properties like Plutonium. The utilization of Thorium as fuel in atomic pile will depend on the production of this new element from Thorium. The circumstance that certain atomic nuclei can be made to break up with large release of energy is not enough to justify their utilization as atomic fuel. The reaction must be self-propogatory. A consideration of how a coal fire is maintained will illustrate the point. By an initial application of external heat to a pile of coal, combustion with oxygen can be made to proceed at such a rate that the heat generated will be sufficient to activate fresh coal particles to enter into combination with oxygen. Of the total heat generated in the body of the fire, a part will be radiated across the surface. Therefore it will not do to have too small avolume of coal, then too much heat will be radiated away, its temperature will cool down and combustion cannot be maintained. In the case of the atomic pile, neutron plays a role anaoglous to that of oxygen. The difference is, that it is a very expensive process to continually supply the pile with neutrons generated outside the pile. But fortunately during the process of fission, each nucleus emits 2-3 neutrons and these neutrons if they can be made to be absorbed by other fissionable nuclei, will make the reaction self-sustaining and thus a reactor pile can be maintained. The limited supply of neutron produced in an atomic pile, introduces an essential difference in its working compared to that of a coal fire. In the latter the supply of oxygen is pratically unlimited, the rate of combustion and therefore the heat developed can be controlled by limiting the access of oxygen; further the presence of oxidisable impurities in the coal, which use up a part of the oxygen supply without generating much heat, does not interfere with the maintenance of the fire. The atomic pile must have also a certain volume in order to reduce the amount of neutron which leak away across its boundary surface, in comparison to that produced in the volume, and further all impurities which like boron and some of the rare earth elements very readily absorb neutrons and do not contribute to the maintenance of the fission reaction, must be rigidly excluded. In the purified uranium metal, a purity of one part in ten million in respect of such contaminants is specified. The conditions therefore necessary for the setting up a self-reacting atomic pile are

(*i*) To isolate and purify a sufficient quantity of fissionable material like U 235 or Pu 239.

(*ii*) To determine from calculation or otherwise, the critical volume of the metal beyond which the fission process once started will be self-maintained. This will be so when the number of neutrons released throughout the volume by nuclear fission is larger than the number lost by absorption in impurities and by escape from the boundary surface of the pile.

Under such conditions, if we assume that a pair of neutrons are emitted during each fission and the neutrons so produced are utilized for fresh fission production, then the rate of fission will increase as $2, 2^2, 2^3$ in a geometric progression. Since the velocity of the neutrons produced during fission is of the order of 10^9 cm. per sec., the time between successive generations in which the number neutrons is doubled is of the order of 10^{-8} sec; an extremely large number of fission will take place in a millionth of a second, resulting in the generation of intense heat and pressure, so that the material explodes violently and an intense compressional wave of tremendous destructive power is propogated. This is the process utilized in the making of atomic bombs. For this purpose it is only necessary to divide the bomb into two parts, each of less than the critical volume, but when the two are brought together, the fission process takes place in it at an explosive rate.

The process taking place in such fast reactors can be controlled by the introduction of bars of neutron absorbing materials at critical points in the reactor pile. The making of such a pile is very expensive, as it entails the very costly separation and purification of the metals U235 or Pu239, and the control is very difficult. Construction of such piles is proposed where the limitation of size of a pile is essential.

Slow neutron reactors.—Both U235 and Pu239 have much larger absorption capacity for slow neutrons of thermal velocities, than for fast neutrons. The great advantage of using thermal neutrons is that the reaction proceeds at a comparatively slow rate and is therefore more amenable to control. At the same time the fissionable material can be largely diluted with other materials which have negligible absorption for slow neutrons, *e.g.*, with U238; *i.e.*, in place of the costly isotope U235, natural Uranium metal can be used, which considerably reduces the cost of the pile but produces consequent increase in

its critical size. Further it involves the introduction of a foreign substance called moderator, collision with which will reduce the velocity of the fast neutrons generated during fission to thermal velocities. It is a well known law of elastic collision, that the transference of energy between two colliding particles is a maximum, when they are of the same mass. Thus the specifications required to be fulfilled by a moderator are (*i*) its mass be as near as possible as that of the neutron, (*ii*) it has no appreciable absorption coifficient for neutron, and it can be obtained in a state of high purity in large quantities. Water otherwise ideal cannot be used, as hydrogen has a high absorption for slow neutrons. Heavy water is next best but very costly to prepare ; it has been successfully used in the U. S. A. and Canada. Its use materially reduces the size of the atomic pile. The best all round material available is graphite. Owing to the inevitable but finite loss of neutron by absorption, the multiplication factor k, *i.e.*, the ratio of the number of neutrons produced by fission to the number of free neutrons present in it at a given time is not much greater than one. As the condition for maintenance of a chain reaction is $k>1$, the critical size of a slow chain reactor is therefore large, and several tons of uranium and graphite are required for a pile. The uranium metal is distributed as cylindrical rods or in lumps in a lattice of graphite, so that fast neutrons produced in one metal lump is slowed down to thermal velocity in the intervening graphite material, before they enter into another lump of metal. Though the ideal shape of a lattice is spherical, for convenience of manipulation it is made of cylindrical shape.

Once a chain reaction starts in a pile, new processes are put into operation, and special measures have to be taken to cope with them. For every gram of fissionable metal 0·999 grams of new elements are formed, some of them or their decay products have high absorption for neutrons, and if they are allowed to remain too long in the pile, they may reduce its activity or even stop the nuclear chain reaction ; so it is necessary to remove from time to time the the uranium or other fissionable material from the pile and to decontaminate it by chemical means, *i.e.*, to remove the fission products from the fissionable material. The fission products are radioactive isotopes of known metals, and so far 75 radioisotopes have been prepared from them, in varying quantities and several of them are finding important biological, chemical and medical applications. In addition to these fission products, a new fissionable material Plutonium is produced. This element is separated and utilized for enriching new atomic piles or for purposes of making atomic bombs. Due to the intense radiations generated during fission and by the radioactive fission products which are extremely dangerous to handle, all the chemical operations have to carried through distance control processes across five feet barriers of protecting concrete shields. Behind these shields are also recording instruments installed for indication of neutron flux at different portions of the pile and for automatic insertion of control rods.

Controls and Safeguards (*i*) Some effective means have to be found to prevent the fission reaction multiplying too rapidly, which might lead to the development of high temperature and pressure leading to the eventual destruction of the pile. This is controlled by placing cadmium or boron rods, which absorb slow neutrons very largely, at suitable positions in the pile, which when inserted will absorb a fraction of the neutrons generated and thus damp down the rate of fission production.

(*ii*) The heat developed in the pile must be removed by circulation of suitable coolants ; possible methods are by circulation of water, gases, gases under pressure and by liquid metals, all of which must have low neutron absorption ; they must be physically and chemically stable when subject to intense radiation, they must not corrode or erode the material of the pile they come in contact with. The heat if removed at sufficiently high temperature may be utilized for driving heat engines. It must be realized that the only way at present known by which atomic energy of fission can be utilized is by way of the heat energy to which it is transformed. As is known the efficiency of heat engines increase with the temperature at which heat is received from the source. At present the highest possible temperature at which a gas turbine can work is 700—800°, and it is still an unsolved problem of atomic pile engineering, to devise a cooling arrangement by which the heat generated in the pile can be removed at this temperature. We shall refer to this problem later.

(*iii*) The type of engine to be selected will also be conditioned by the special hazards which accompany the working of an atomic pile, *viz.*, the release of enormous quantities of gamma rays and neutrons. A chain reacting pile producing sufficient heat to generate 100,000 h.p. would simultaneously emit radiation equivalent approximately to 500×10^6 gms. of radium. In order to provide sufficient biological protection from neutron, etc. five feet thick of concrete shielding surrounding the pile unit will be required. Even a low power reactor will require 50 to 100 tons of shielding material. This puts a limit to the construction of a portable low power pile unit.

Hanford Pile.—In Smyth's report the working of four atomic piles has been described. Of these, the one built at Hanford, has been made the basis of plans for future development of atomic piles for power generation purpose. The pile is built of graphite

blocks with a lattice structure, for insertion and and removal of cylindrical rods of uranium and of neutron absorber. The utility of such arrangement for removal and purification of uranium rods has been described before, as well as the instruments which, indicate and control the neutron flux in the pile at different points.

The coolant used is pure river water, which is circulated through aluminium tubes enclosing the uranium rods. The latter are also encased in aluminium jackets to prevent their oxidation by water. The temperature of the circulating water is kept below 100° to prevent the oxidation of the aluminium pipes and jackets. Aluminium was selected because of its low neutron absorption and high thermal conduction. After circulation through the pile the cooling water is kept in a reservoir for some time in order to get rid of the radioactivity induced in it. The heat thus removed by the coolant cannot be employed usefully as source of heat in a thermal engine, unless its temperature is raised considerably over 100°.

The Hanford pile was we believe used for the production of Plutonium required for manufacture of atom bombs. It was after the termination of war with Japan that attention was directed to investigations on nonmilitary applications of atomic energy. Future scheme for the utilization of heat developed in an atomic pile will depend on the finding of suitable coolants which in addition of other desirable properties will be able to transfer heat to the working substance of a turbine at the highest temperature at which the latter can work, *viz.*, 700–800°C. Amongst the proposals which have been made are (*i*) that coolant, which may be an inert gas, will be made to circulate in a closed circuit to prevent the discharge of fission products into the atmosphere.

(*ii*) There will be a thermal exchanger in which the heat will be transferred from the coolant to the working substance, which circulates in a closed secondary circuit. The working substance which may be steam, vapourized mercury or hot gas will be used to drive a turbine. In spite of present limitations, atomic fuels offer certain possibilities for future improvement over ordinary fuels. For example there is no theoretical limit to the high temperature which can be obtained, with the consequent increase in thermodynamic efficiency, except the ability of the materials of construction to withstand working at such high temperatures.

Economics of Nuclear Power Plants.—A group of engineers belonging to the Clinton Laboratories and the Monsanto Chemical Co. were requested by the Baruch Committee on Atomic Energy to prepare a report on the cost of nuclear power based on information at present available. The model taken was a modified Hanford Plant, about whose working design and operation, information is available. In such a study the commercial plant was considered to differ from the Hanford pile in two important respects.

(*a*) The operating temperature was assumed to be high enough to supply power.

(*b*) All plutonium formed was assumed to be recovered, only for later consumption in the pile. No such plant has yet been built and no insurmountable difficulty stand in the way, but still extensive research and development problem will be required to be solved as they arise. The complete nuclear plant will contain not only the pile itself, but all the auxiliary equipment and installations needed to operate a continuous thermal plant. It is estimated that an atomic fuel plant, producing 75,000 KW, could be built in a normal locality in the eastern U. S. A. for approximately $25,000,000. On the assumption that the plant would operate at 100% of capacity, and interest charges on the investment would be 3%, the plant could produce power at 0·8 cent per KW. hour. A coal power plant would under same condition cost $10,000,000. The operating cost will depend on the cost of coal; assuming it to be bituminous coal, of 13,600 B.T.U., delivered at $7·00 per ton to the furnace of a power plant in the eastern U. S. A., the cost of power production, under the same assumptions of operating capacity and interest charges, per KW. hour would come to 0·65 cent. Equality of operating costs between coal power plants and nuclear power plant would be reached if the coal cost is over $10 per ton. It is thus seen that substitution of a power pile for a standard coal one will involve no saving. The large capital investment of atomic fuel required to reach critical size, the chemical processing, the shielding, the remote controls, the insurance against hazards, and the waste disposal problems, add considerably to the cost of operation. If only atomic fuel becomes considerably cheaper than the equivalent amount of coal, will there be favourable competition. Again the cost of fuel is only about one-fifth of the total cost of producing electricity for domestic purposes, where coal is easily available. The cost of distribution of electricity is much more and this cost is not affected at all by the substitution of atomic power for fuel. In other words if atomic fuels could be obtained absolutely free, the maximum possible saving would be only 20%. On the other hand if one paid twice as much for atomic fuel as for coal, the cost of delivering electricity would be increased only by about 20%. In certain large scale industrial operations the fuel costs may represent more than one-fifth of the total cost of electricity produced.

But economic consideration do not alone determine developments of this kind. In isolated re-

gions where transportation is difficult, one does not count the cost involved. The present radius of useful distribution of electricity is somewhere around 200 to 300 miles. In inacessible territories, without any hydraulic power available, power piles could be advantageously distributed and may find their first applications. Similarly in large units of transportation, where bulky shielding could be installed—as in large ships, atomic fuel might be used for many trips round the world without refuelling.

Piles can be used for heating as well as for power. Industrial and domestic heating constitute an additional promising field for the peace time use of atomic fission. Power piles may be used for the distillation of water from the sea. Many uses of distilled water so obtained, in areas situated near the sea, can be envisaged.

Sources of fissionable material—Uranium.—According to pre-war statistics, the amount of high grade uranium is limited. Valuable deposits are found in Belgium Congo and northern Canada. Lower grade deposits are found in Colorado, Czechoslovakia and other scattered regions. Uranium is derived not only from uranium ores, but in many cases it is or might be derived as by product of ores of other metals, mainly vanadium.

It appears from such pre-war information that the world supply of high grade uranium is entirely inadequate to supply the world's power and heat requirements even for a few years ; the supply of extremely low grade ores would theoretically exceed the heat available in the world's total coal and oil reserves. Attention is therefore being directed to the possibiity of utilizing low grade uranium ore for extraction purposes.

Thorium.—The other natural fissionable material is thorium. But "thorium by itself or in combination with any other natural material except uranium, cannot maintain a chain reaction. Without uranium, chain reaction is not possible, but with fairly substantial quantity of uranium to begin with and suitably large quantity of thorium, chain reaction can be establishted to manufacture material which is an atom explosive ,and which can also be used to maintain other chain reaction."

The statement quoted above is of importance to us in India, on the feasibility of constructing atomic pile from local supply of atomic fuel. This country so far as is known has no large sources of high grade uranium ore, on the other hand there are extensive deposits of thorium containing minerals.

(To be concluded)

WHEAT RUSTS AND THEIR CONTROL

J. F. DASTUR,

HEAD OF THE DIVISION OF MYCOLOGY

and

B. P. PAL,

HEAD OF THE DIVISION OF BOTANY AND ASSISTANT DIRECTOR,
INDIAN AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI

INTRODUCTION

THE CEREAL RUSTS—A SOURCE OF LOSS ALL OVER THE WORLD

RUSTS of cereals are potential causes of great destruction in all cereal-growing regions of the world ; under favourable conditions one or other of the three rusts, especially the black and yellow rusts, is capable of more or less totally destroying the crop, as has been the case this year in Central and Peninsular India.

The reduction of yield of wheat in India as a result of the rust epidemic has been so great that India today faces a grave food crisis. The public would therefore naturally be interested to get some information regarding the rust problem in its various aspects and to know what other countries are doing to solve the problem.

In U. S. A., Canada and other countries damage done by rusts has been carefully assessed. For example in 1935, the U. S. A. had estimated an yield of 731,045,000 bushels of wheat but due to a rust epidemic, seasonal conditions being favourable, the total yield harvested was only 599,000,000 bushels, *i.e.*, a loss of 132,045,000 bushels ; the same year in Canada the difference between the estimated yield and the yield actually harvested was 91,029,000 bushels ; here also the loss was due to damage done by rust. Gussov estimates the average annual loss in Canada to be over £5,000,000, and according to Greaney, Canada loses annualy, $40,000,000 from the same cause. Mehta in India considers the loss

to be about Rs. 60,000,000. In Kenya, Burton considers rust to be "the limiting factor in production" of wheat.

How rust originates and spreads: Rust is a parasitic organism of a very complex nature, belonging to the vegetable kingdom; it can survive only on its living plant hosts; this parasite is highly specialized. Take the example of black rust of wheat and that of oats: both are caused by *Puccinia graminis* but the wheat rust will not infect oats and *vice versa*. For the development of disease, three factors are usually involved, *viz.*, the pathogen, the host and suitable climatic conditions; all these three factors combined together bring about an epiphytotic, *i.e.*, an epidemic, and therefore in the study of an epidemic each of these factors has to be carefully studied. For the development of an epidemic is required an "interaction of a number of environmental factors operating in proper sequence over a long period of time"; for these reasons the problem of the epidemiology of the disease is "extremely intricate and puzzling" according to Stakman. He states "Nevertheless, as a result of extensive investigations by the United States Department of Agriculture and the Minnesota Agricultural Experiment Station during the past twenty years, many of the basic factors governing the development of epidemics are now known, although nearly every major epidemic that has been studied has followed a different course." In India also we have to study "the basic factors governing the development of epidemics", and the course they follow.

On wheat there are three rusts, the black, yellow and brown, of which the first two are considered to be very important in India. Wheat rusts are not ordinarily seed borne; a wheat plant gets infected by means of the uredospores, or what are known as repeating spores or red spores; successive generations of such spores are produced on the plants and thus the disease spreads from plant to plant and field to field.

Dissemination: Large numbers of spores are carried by wind currents which help in the dissemination of the pathogen. In the spread of rust, man and insects do not seem to play an important part. There is enough evidence to show that new races of rust are disseminated widely by wind and thereby become established over large areas; for example, it has been shown that 'race 56' of the wheat black rust fungus was not known in America prior to 1928 but by "1938 it had been isolated from all states from which rusted wheat was obtained in the U. S., extending from the Pacific coast to the Atlantic and from Northern-Mexico into Canada. . . . The wind was so effective an agent of dissemination that a little initial inoculum, at least relative to the amount that developed subsequently, increased in various infection centres until it became so large as to enable a new physiologic race to become the most prevalent and most widely distributed in North America."

Alternate and collateral hosts: The black rust fungus in order to complete its life cycle has to spend a part of its existence on a host other than wheat, *viz.*, the barberry, *i.e.*, the fungus has an "alternate host" besides wheat. In many parts of the world the two stages of this fungus on wheat are also found on other hosts such as grasses, and these hosts are known as collateral hosts.

Physiologic races: The three rusts of wheat can be readily distinguished from each other, but each rust has distinct entities or groups of forms which cannot be distinguished from each other on a morphological basis but still they have different parasitic capabilities; black rust of wheat has got about 200 such forms, each of which is known as a physiologic race and is given a distinguishing number.

Control Measures: From the study of rust, control measures that are generally recommended are:

(*a*) the eradication of alternate hosts and collateral hosts;

(*b*) destruction of "volunteer" wheats, *i.e.*, plants from self sown seeds and avoidance of "out-of-season" wheat crops;

(*c*) use of sulphur and other fungicides;

(*d*) certain fertilizers, especially nitrogenous ones, have been known to make plants more susceptible to disease whereas other fertilizers are known to make the plant more resistant to rust infection;

(*e*) cultural practices might influence the intensity of rust infection; but the most important method of control is the breeding of rust resistant varieties.

Study and Control of Wheat Rust in the most important Wheat growing Countries

United States: The prevalent rusts are black and brown. Black rust is perpetuated in the aecidial stage on barberries, the alternate host of this rust. In the year 1917 Stakman discovered the presence of physiologic races within black rust. Since then a large number of races have been found, new ones arising out of hybridization on barberries or by mutation. Billions of barberry bushes have been destroyed at enormous cost. Every year new improved varieties resistant to rust are being evolved. It has been reported that there is a seasonal inter-

change of rust between the United States and Mexico. In the U. S. A. a programme for wheat breeding for rust control was initiated as early as 1911.

Canada: Black and brown rusts predominate, yellow being confined to the hills.

According to Buller and Craigie south winds blow the spores of black rust into Canada. Infected barberries supply local inoculum and also produce new physiologic races. In addition to the eradication of barberries at considerable expense, systematic breeding of resistant varieties has been in progress since 1922. New varieties are evolved every 3-4 years, to take the place of old ones in view of changing physiologic races.

Australia: Black rust predominates, although brown is also found. Rust studies were started in 1921 and Waterhouse found nine races of black rust. Breeding of resistant varieties has been in progress since the last twenty years and recently eradication of barberries has been suggested.

U. S. S. R.: All the three rusts are found in different parts of the country. Shitjkova Roussakova recorded the overwintering of black and brown rusts in North Manchuria. Over-wintering of yellow has been reported by Roussakov. In Russia there has been a programme for wheat breeding since 1930.

Dissemination and Epidemiology of Rusts

Direct evidence of the dissemination of black rust of cereals and grasses to very long distances by air currents has been obtained especially by American and Canadian workers. In connection with the long-distance dissemination of spores it is not possible to locate the origin of the inoculum. "Under most conditions it is almost impossible to determine whether the spores originated in the immediate vicinity, or have been carried by the wind from remote places, irrespective of the altitude at which they have been caught". Ukkelberg has calculated that if "uredospores of *Puccinia graminis tritici* (black rust of wheat) reached an altitude of 5,000 feet their dispersal distance in a 30 mile wind would be about 1,100 miles. Both Lambert and Stakman have shown "that under certain conditions rust spores of *Puccinia graminis* are blown from the far south into the Dakotas and Minnesota, travelling more than 1,000 miles in about two days and up in Canada in a short time thereafter".

The spores have been found to remain viable in spite of "vicissitudes of wind dissemination". Russokov has shown that uredospores of the black rust fungus "can be carried 50-250 km. over the sea without losing their viability".

Waterhouse considers that wheat stem rust or black rust may have been introduced in Australia by "air-borne uredospores from cereal crops in India or elsewhere"; barberry, the alternate host of black rust, was introduced in Australia much after black rust was first found on wheat, and "it is known that rust spores have been carried thousands of miles by wind, frequently associated with atmospheric dust". He has established the presence of nine physiologic races of black rust in Australia and New Zealand. From the distribution of these races over a period of several years he finds that there is a distinct change in the rust flora commencing in the 1926 season and that the changes in Australia and New Zealand are "parallel", the transport of uredospores taking place across the Tasman Sea.

Roussakov and Shitikova-Roussakova are of opinion that wheat rusts (black and brown) are probably introduced into the Amur region of Siberia by wind-borne spores from North Manchuria, where they over-wintered in the uredial stage". Chabrolin believes that black rust in Tunis in Africa "must be re-introduced every year from outside sources, and it seems likely that spores are probably blown across the Mediterranean Sea from Sicily and Sardinia".

Wind-borne spores of yellow rust carried from Washington, Idaho and Montana are considered by Sanford and Broadfoot to be the cause of the annual recurrence of the rust in Alberta, Canada.

Bailey, Craigie, Greaney and other Canadian workers have shown that black and leaf rusts do not over-winter in Manitoba, and that their uredospores are "always present in the air in advance of the infection of the crop", and therefore, they consider that these two rusts of wheat are regularly introduced into Manitoba by wind-borne spores from United States.

Mehta has shown that in the plains of India rust spores do not survive the summer and therefore, he concludes that the infection must be coming from other sources.

Rapidity of the spread of infection: The black rust pustule may contain 50 to 400 thousand spores; enough to infect almost an acre of wheat crop; each of the spores is capable of infecting a healthy plant and producing successive generations of spores in a week's time. The infected plant has many such pustules and therefore the number of such spores developed on a plant may run into many millions.

Control Measures

Eradication and "clean-up": The question as to how the rust is carried over from season to season has to be considered in evolving control measures. Black rust spends one part of its life history on the wheat plant, barley plant or some wild grasses and

then completes its life cycle on barberries. Teleutospores (the black spores or winter spores) produced on wheat or barley lie dormant in cold countries till the end of winter when they are capable of infecting tender leaves of barberries. On this "alternate host" the cluster-cup bearing stage is produced. Spores produced in these cups infect young wheat plants which in turn develop the uredospores (summer spores or red spores) and later the teleutospores.

Barberries therefore serve as a foci of infection for the new crop in spring.

The connection between the aecidiospores (spores from the cluster-cups), disseminated from barberries, and the occurrence of local epiphytotics and widespread regional epiphytotics has been well established.

It would naturally be therefore, thought that the best way of controlling rust on wheat would be to eradicate the alternate host so as to prevent the parasite from completing its life cycle.

Therefore in 1918, United States Department of Agriculture in co-operation with other States started a barberry-eradicating campaign. In two years about 16,000,000 bushes and seedlings were destroyed; however "in 1027, 10 years after the campaign started, 1,688,554 bushes, sprouts and seedlings were found. During May and June of each year a large proportion of the remaining bushes were rusted. One heavily rusted barberry bush may bear about 70,000,000 aecidiospores".

In Australia and India, however, barberries do not play an important part in the seasonal dissemination of rust on wheat, because the problem is not one of over-wintering but of over-summering.

In Australia the "living rust in the uredospore stage is present on sporadic crop plants or susceptible grasses all the year round. This inoculum is responsible for initiating the rust attacks in the crop. Not long ago it was stated that complete control of wheat stem rust could be had if only agreement could be reached, whereby all growers everywhere in Australia undertook to grow no wheat for one particular season, say from April to December. However it will be seen from accumulated evidence that this would not solve the problems". Waterhouse has made field collections of black rust and brown rust of wheat and black rust of oats month by month for about 15 years and he observes, "Attention is drawn to the fact that opportunities for collecting rusted material have been distinctly limited. It is certain, much more rust was available in the field that is indicated by the collections submitted for examination." The rusted material obtained during the non-wheat-growing season (late summer and autumn) has consisted mainly of "volunteer" wheat or oat plants as the case may be but some of the specimens were wild grasses. Some came from the wheat belt. Others were collected in regions of better rainfall, *e.g.*, on the coast. But the latter could easily serve as foci whence infection could spread to the main wheat growing areas. In considerations of rust control there can be no possibility of eradication by simply not growing a crop for a season. Other means must be sought".

Sulphur and other fungicides: Work done in the U. S. A. and Canada shows that precipitated sulphur is toxic to rust spores. Lambert and Stakman used 30 lbs. of sulphur per acre of wheat and found that, in some experiments, one application virtually controlled rust, while in others, five applications were ineffective. Greaney in Canada reports that the "yield and quality of grain of both wheat and oats were significantly improved by dusting. In 1930, a severe rust year the yield of Marquis wheat was increased 400 per cent by dusting. He is of opinion that the fungicidal value of sulphur increases in proportion to the fineness of the rust particles". He recommends sulphur dusting as a method of rust control "for the use of experimentalists, seed growers, and grain exhibitors wherever destructive epidemics of cereal rusts occur". He observes, that once a plant was infected, subsequent applications of sulphur served only to prevent further infections.

Recent work done in Russia shows that in general sulphur dust markedly controls rust and consequently the yield is increased ; Russian workers have used flowers of sulphur. Roussakov recommends dusting to be first done as soon as the pustules appear and to repeat the application at 5-day intervals at the rate of 15 kg. per ha. till the milk stage of the crop is reached. According to Sibilia wheat dusted with copper dust "asporital" showed practically no infection ; Shitikova-Roussakova used 5 per cent sodium silicoflouride, 93 per cent fine clay and 3 per cent thin lubricating oil for the control of rusts.

Hart and Allison found that borax, picric acid, paratolouene-sulphonylamide and arthotoluene-sulphonylamide reduced the incidence of infection. None of these treatments has, however, been found to be applicable to large areas or economically practicable.

Effect of fertilizers and cultural practices: Work done outside India has indicated quite clearly that, in general, nitrogenous fertilizers tend to increase susceptibility of the wheat plant, while phosphate has the opposite effect. Experiments in which various proportions of N.P. and K were applied showed that rust was more severe when K was deficient in the ratio. As a result of such investigations and observations it is now generally accepted that rust may be reduced in severity by reducing the proportion of N in the N : P : K ratio.

Experiments have also been carried out with minor elements and miscellaneous substances but these have not yielded promising results.

Cultural practices have, generally speaking, not been shown to have any direct effect on rust incidence except that practices which tend to promote early maturity usually help the plants to escape the most destructive rust. There are indications that rust may be unusually destructive in irrigated wheat.

Breeding: Where resistant varieties exist or have been bred, these constitute the simplest and least expensive method of disease control for they entail no additional expenditure or work to the grower.

Chester (1946) in his comprehensive book on cereal rusts states: "Adjustment of time of sowing, fertilization, destruction of volunteer cereal plants, applications of fungicides,—these are but adjuncts to the fundamental solution of the cereal rust problem; the breeding of cereal varieties that are resistant to rust,—is at once the most certain and effective, and the most economical means of checking the ravages of the cereal rusts." Breeding of wheat for rust resistance may be said to have originated with the pioneer work of Farrer in Australia at the close of the last century; this work was so successful that rust resistance as a method of rust control was well established in Australia. In the early years of this century, Biffen at Cambridge applied the newly rediscovered Mendelian principles of heredity to breeding wheat for resistance to yellow rust, the only rust which is of economic importance in England. This was followed by very intensive work in the U. S. A. and in Canada; this dealt mainly with the black or stem rust but following the epiphytotic of brown or leaf rust which swept America in 1938 and destroyed the famous black-rust resistant variety Thatcher, breeding for resistance to brown rust has also been taken up seriously.

The breeding of rust resistant wheat has been found to be difficult and slow. One circumstance contributing to this in the earlier work was the lack of knowledge of the existence, in the rusts, of physiologic races, morphologically indistinguishable from each other, which vary in their ability to attack different varieties of wheat. Early breeders were puzzled by the failure of certain varieties to maintain their resistance from year to year, and in different localities. When however, Stakman and Piemeisel demonstrated the existence of physiologic races in *Puccinia graminis tritici* (the black rust fungus) in 1917, the reason for these apparent breakdowns of resistance became clear. Most wheat varieties are resistant only to certain physiologic forms and the particular forms present vary from locality to locality and from year to year.

Nearly 200 forms of black rust are now known, and similarly physiologic races exist in the brown and yellow rusts also. New forms may arise by hybridization or mutation. While the existence of these numerous physiologic races renders the task of breeding rust-resistant wheats an arduous one, encouraging features also occur. These are the discovery that certain varieties which are susceptible in the seedling stage exhibit considerable resistance when mature, and that resistance to a number of physiologic races may be governed by a single genetic factor.

Considerable success has attended the attempts to breed black rust resistant wheats and varieties such as Kanred, Hope, Ceres, Marquillo, Thatcher and Renown have proved very useful. Brown rust-resistant strains have also been bred and some combine resistance to both the black and the brown rusts. As indicated earlier, wheat breeding for rust resistance has also been in progress in many other countries. Recent developments include the use of the less well-known species of wheat (*Triticum*) and of allied genera as resistant parents for hybridization work.

Work done in India

Our present knowledge of the rusts of cereals in India is entirely due to the researches carried out by Mehta during the last two decades. To him goes the credit of establishing the presence of physiologic races, which is being made practical use of in breeding resistant varieties. Formerly it was taken for granted that barberries found in the Simla Hills were responsible for the spread of rust on wheat but Mehta has shown that these barberries play a very minor part in the dissemination of wheat black rust.

All the three rusts of wheat are found in India. Black and yellow rusts also infect barley. Black rust is found in all parts of the country, including the hills as well as the plains. The brown also occurs everywhere, excepting in a small part of peninsular India. Yellow rust however has not been observed in the plains of peninsular India.

Physiological studies, as well as the distribution of each of the three rusts, in this country show that black rust is able to withstand warm weather better than yellow rust, the latter thrives better under comparatively cool conditions; the brown rust occupies an intermediate position. As a consequence of the temperatures prevailing during the growing season of wheat (for instance, the Punjab has a comparatively lower temperature during the greater part of this period), the yellow and brown are common in the Punjab; all the three are equally common in U. P. and Bihar; and black rust predominates in

the plains of C. P. and Deccan. These rusts are capable of doing considerable damage, particularly yellow and black, in the provinces where they commonly occur, their intensity depending on the prevailing weather conditions.

In the plains, the summer heat that follows the harvest, kills all the uredospores of these rusts. Consequently, there is no local source of infection when the crop is sown in the plains.

In the hills, on the other hand, all the three rusts have been found to over-summer on stubble, volunteer wheat and "out-of-season" crops, at different altitudes ranging from 4,000 to 8,000 ft. above sea level. This has been confirmed by repeated observations extending over a period of 20 years. Crops in the hills get infected rather early in the season in the neighbourhood of these rusted volunteer wheat plants and the spores are then disseminated by winds to the foot-hills and the plains causing fresh outbreaks.

In general, according to Mehta, rusts appear earlier at places in the foot-hills than those situated farther away in the plains.

Spores of all the three rusts have been caught on aeroscope slides at a large number of stations in the plains before the local appearance of rusts,, showing that the spores are introduced by wind. Mehta, from his study of wind trajectories correlated with spore showers, concludes that the air currents had either come from the hills or passed over areas where rust had appeared earlier.

In addition to over-summering in the hills on volunteer wheat, two important foci exist according to Mehta ; where, due to early crops, there is plenty of rust every year at the time wheat is sown in the neighbouring plains. These are Central Nepal in the north and the Nilgiri and Palni hills in the south.

It should not be taken from what has been said above that every locality in the plains gets infection direct from the hills. In fact, after the initial infection of a few plants in any field, rust spreads very fast to the neighbouring plants and other fields in that locality, under favourable weather conditions. Later on, infection may spread to other places in the plains as a result of air-dissemination of spores. Wild grasses have been found to be collateral hosts of some of the cereal rusts in other countries and a considerable amount of information is available pertaining to their reaction to those rusts in Europe, Canada, United States and Australia. In India only the black rust found on *Bromus patulus* and *Brachypoduim sylvaticum* has been definitely shown by Mehta to be the same as that on wheat. Infested *Bromus patulus* has been found at several places in Kashmir and the Simla hills. These grasses are annuals and their growing season is the same as that of wheat. No over-summering of rusts has, however, been noticed on these grasses.

The study on physiologic races carried out by Mehta during the last 20 years has so far resulted in the identification of nine races of black rust, eight of brown and ten of yellow, some of which have not been found outside India. It is probable there may be other races in this country which have not been identified as yet. Further, it is very probable that more races may be evolved as a result of hybridization and mutation or may be introduced from other countries. In Canada new strains of brown rust were found in 1946 which caused heavy infection of Regent wheat and other resistant varieties.

Mehta from his extensive study of wheat rusts in India makes the following recommendations.

"It is necessary therefore, that in the meanwhile wheat and barley crops should be saved from devastating epidemics, year after year, caused by all the three rusts taken together, by controlling the inoculum at the source, *i.e.*, in the hills. Considering the huge loss of Rs. 60 millions or so per year to these crops caused by rusts, the writer is strongly of the opinion that a good deal of damage could be mitigated by rigorous destruction of self-sown plants and tillers, which 'carry over' the rusts, 1-2 months before sowings in the hills. This method is thoroughly practicable because of very small individual holdings in the hills where the crops in question are grown on small and narrow terraces."

Theoretically his recommendation for saving the "huge loss of Rs. 60 millions or so per year" may be sound, but the question to be considered is "Is the measure recommended practicable, both physically and economically"? When we consider the "clean-up of self-sown wheat" we have also to consider the probable existence of grasses on the hills which are affected by the same rusts as wheat and barley ; if there are out-of-season and self-sown wheats certainly there are also out-of-season and self-sown grasses which are of equal importance as centres of foci of infection as the wheat and barley plant ; even granting that these grasses be not centres of infection there is the important question of differentiating young wheat plants from those of some of the grasses which even experts at that stage may fail to identify ; the self-sown wheat plants are not always to be found on the beaten tracks of the hills ; they will be scattered all over, perhaps more often than not in very inaccessible places and a thorough search for these plants, even if we do not include grasses, would be impossible. Another factor that militates against a thorough clean-up is the time factor. The clean-up has to be done between the harvest of one season

and the sowing of the next, *i.e.*, within the three months, July to September ; this period is the monsoon season and therefore the question arises for how many days during this season the clean-up would be physically possible on the hills. The total number of days in these three months when even the easily accessible places can be carefully examined would be considerably reduced. Taking these facts into consideration the number of men that would be required for this clean-up would be very large indeed and so would be the expense. The question therefore naturally arises would this clean-up even yield the cost spent on removing the self-sown plants and if and whether it would give definite results.

Another question that is closely linked up with this problem is whether we have by now traced all the centres of foci of infection ; looking to the topography of the country it is not at all improbable that we have as yet not got the complete picture. Self-sown wheats, and wild grasses, that may be the collateral hosts of wheat rust, may be found scattered over the Vindhyas, Satpuras, Western Ghats, Palni Hills, the Nilgiris and other ranges with altitudes of about 3,000 and over where the rusts are able to over-summer ; in some of these hills volunteer barley plants may also be present.

It may be argued that if a large part of the source of inoculum in the shape of "out-of-season crop' is removed the infection would be materially reduced ; that the infection from volunteer plants and wild grasses will not be so much as to cause an epidemic and that the absence of the "out-of-season crop" will considerably delay appearance of rust on the crops in the plains. This year we have authentic information of rust having appeared in Gwalior and Central India by the middle of November, and therefore a nearby focus is indicated. We have seen that a black rust pustule may contain 50-400 thousand spores, enough to infect almost an acre of wheat ; and therefore even if no "out-of-season" crop is cultivated the infected volunteer wheat remain potential foci of infection all that perhaps can be expected from not growing the "out-of-season" crop would be that the infection might be delayed ; but when the infection can come as early as the middle of November the delay of the infection by two or three weeks would not materially help in warding off an epidemic. But one cannot be dogmatic.

Gaps in our knowledge.—The knowledge we have at present regarding the rust problem is not wholly complete ; *e.g.*, we do not know what are the predominant physiologic races on volunteer plants and collateral hosts month by month. In Australia, race 34 suddenly appeared in 1926 and since then it has become a predominant race ; but in India this race was first observed by Mehta about 1941 ; there is not much information available regarding the presence of collateral hosts and alternate hosts in the various hills of India ; there has been a lack of systematic study of the epidemiology of rust ; the probability of infection coming from neighbouring countries like Afghanistan and Iran have not been systematically considered.

Mixed cropping.—We have no reliable data regarding the effect of mixed cropping on the incidence of rust and on the value of the crops. It is worth investigating to what extent it constitutes an insurance against loss owing to epiphytotics.

Breeding.—Although it was realized in the first decade of this century that breeding for resistance against rust was necessary and work was actually started at Bombay, Cawnpore and Pusa, not much progress was possible because of reasons which have already been mentioned when discussing the work done in other countries. However, certain of the strains possess a fair measure of mature resistance and in the recent severe epidemic the following wheats have been reported to have fared well. I. P. 52, I. P. 4, I. P. 165 and Pb. C. 591. Several of the new 'Pusa' wheats which were under trial have also yielded well in spite of the epidemic.

It is necessary to lay stress on the fact that the work of breeding resistant varieties based on the knowledge of physiologic races is only of recent origin. All previous work was of a haphazard nature, selection having been made on the behaviour of wheat varieties at a certain place in any one year without reference to the physiologic races which may be present in the locality. Systematic breeding of rust resistant varieties was started 12 years back based on the number of physiologic races found by Mehta. Since then,, some more races have been found. Work was started at Simla, in Bombay and in the Central Provinces. At Simla the aim is to secure resistance to all the three rusts ; and progenies of crosses between Indian and exotic types are tested both in the seedling and adult stages. High resistance to all the physiologic races has been achieved separately for each rust, and the work is at a stage when synthesis of resistance to all the three rusts simultaneously is being attempted by means of a double cross made on a large scale. The Simla work is intended to provide rust resistant wheats for the hill areas only (the portion of the scheme submitted by the Indian Agricultural Research Institute, relating to the plains was deleted by the Indian Council of Agricultural Research, by whom the scheme is financed).

In the Central Provinces and Bombay, the work is concerned with resistance to black rust only which is ordinarily the dominant rust in those Provinces.

Further Work required to be done in India with a view to control Rust

It is now essential that an assessment of damage done by rusts at different stages of growth of the crop should be made all over India. The Provinces, States and I.A.R.I. should be able to draw up a common programme of work for the necessary experiments.

Dissemination.—A more detailed study of the dissemination of the rusts should be carried out. The study should include the study of rusts found on wild and cultivated grasses on the hills of India. A search should also be made for alternate hosts, *viz.*, barberries and *Thalictrum* in the Nilgiri and Palni hills and in the hills of northern India.

Epiphytotics.—If we can correlate the effect of a sequence of climatic factors with the incidence of rust and thereby be able to forecast an epidemic, it may be possible to carry out in time, such prophylactic measures as our study of control measures proves to be satisfactory. The effect of temperature, rainfall, dew, clouds, etc., has to be critically studied with the help of instruments, such as thermohygrograph, anemograph, automatic rain gauge, dew recorder, sun-shine recorder.

Physiologic races.—For the study of physiologic races it may be advisable to divide the country into three groups, *viz.*, Group A: Bombay, Hyderabad (Deccan), Madras and Mysore; Group B: Central Provinces, Central India and Rajputana; Group C: N. W. F.-P., Kashmir, Sind, Baluchistan, Punjab, U. P. and Bihar.

Each of these Groups would test rust samples from its area and test seedling and adult resistance of wheat cultures and hybrids required by the Provinces and States included in the group.

Rust nurseries should be established in different parts of India where there are Agricultural Farms.

It is absolutely necessary that the work on rusts should be carried on an All-India basis and that the different experiments should be laid out in consultation with a statistician; all the results obtained, by different workers in India should be collated together by the statistician.

A detailed study of controlling rust by the use of sulphur and other fungicidal dusts needs to be carried out by Provinces and States.

Effect of fertilizers and cultural practices—mixed cropping.—The incidence and intensity of rust on wheat varieties manured with varying proportions of N, P and K should be studied to find out to what extent applications of these affect the incidence of rust and the yield of wheat; the effect of varying amounts of irrigation and different dates of sowing should also be studied.

In many parts of India some crops are sown as mixed crops. While it is unlikely that such a system can affect the intensity of rust infection (rust being wind-borne), there is the possibility that it is a form of insurance against loss of one crop (wheat). As we have not yet got many rust resistant varieties and it may take some time to cover the whole of the wheat area under such varieties it is worth while to ascertain whether mixed cropping is or is not more paying, taken over a period of years. Experiments should therefore, be laid out to work out the ecnomics of growing wheat as a pure and as mixed crop.

Breeding.—Work on breeding wheats resistant to the rusts requires to be greatly extended and intensified. The main line of work should be (*a*) Study of wheat varietal collections for rust resistance; (*b*) Hybridization between suitable varieties to combine a high degree of rust resistance with other agronomically desirable qualities; and (*c*) Breeding work with the progenies of these crosses to obtain the desired strains.*

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* This paper has been written in consultation with and on the basis of discussion with Dr J. N. Mukherjee, Director, Indian Agricultural Research Institute, New Delhi.

PLASTICS EXPOSITION AT NEW YORK

SUBODH KUMAR MUKHERJEE

MASSACHUSETTS INSTITUTE OF TECHNOLOGY,
CAMBRIDGE, MASS., U. S. A.

THE tremendous growth and development of this industry hardly known about a decade ago was fully evidenced in the first National Plastic exposition at New York held under the auspices of the Society of Plastics Industry, Inc. of U. S. A. The chairman of the exposition committee opened the show by cutting through a vinylite plastic applied by the U. S. Navy Laboratories to the front door of the Grand Central Palace where the exhibition was being held. This was also a display of a plastic of sealing machinery and guns to prevent deterioration and rust, and is largely employed by the U. S. Navy.

In the course of his opening address, the chairman stated that the progress of the plastics may be estimated from a production of about 310,000,000 pounds in 1940 to more than a billion pounds today. Investment on plant and equipment has increased tenfold since 1932, and at present, demand for plastics far exceeds the supply. The industry is currently expanding its material-producing facilities by more than a $100,000,000 for new plants.

Plastic motor boats are now being moulded as a regular routine manufacturing procedure. It has a great future as a building material. Developments are underway which will make it possible to build a home with large wall sections of low-pressure moulded panels. Structural parts of furniture and upholstary are newer avenues for using plastics for still better products, whereas, the textile field has only begun to see and feel the impact of plastics.

DuPont exhibited six new developments for the first time. They are (1) "teflon"—a plastic that withstands all acids. This is made by polymerizing gaseous tetrafluoro ethylene to yield a solid granular polymer which can be extruded or compression moulded. It resists the action of such reagents as *aqua regia*, chlorosulfonic acid, acetyl chloride, boron trifluoride, hot H_2SO_4, hot HNO_3 and boiling solutions of sodium hydroxide.

It is not adversely affected with temperatures as low as $-75^{\circ}F$ or as high as $572^{\circ}F$, and retains all the useful properties at these extreme temperature conditions.

The second is a nylon plastic sheeting for leather-like applications. The third is cellular cellulose acetate (CCA)—a foamed pastic lighter than cork. It is suggested for use in the manufacture of airplane floor panels, in refrigerators, and sections of prefabricated houses. CCA is lighter than cork and combines insulation against heat and cold with high structural strength when bonded between two sheets of metal, wood, or plastic. The density is about 4-5 lbs. per cubic feet. The fourth are BCM resins for structural panels reinforced with glass fabrics or other materials. The fifth is patterned "lucite" in shatter resistant sheets, and the sixth, luminescent lucite sheets which glow when exposed to ultra-violet light.

General Electric Company showed a high temperature and heat resistant rubber—the silicone rubber—which will find extensive use as a gasketing material for all chemical process equipments, furnaces, etc., working at high temperatures for a great length of time.

Paint manufacturers who were hard up so long with natural oils and resins will find as an effective substitute, the Goodyear Tyre and Rubber Company's new product, pliolite S—5m. a new synthetic copolymer resin. This company has also produced a new fabric which is moth-proof, water-proof, scar-proof, and scuff-proof. It is woven from a new thread made from "plio film", which has been so long produced in the form of sheets or films. A plio-film fibre can now be produced which can be twisted into a thread and then woven into a fabric. Plio-film fibre, however, will not be placed on the market until natural rubber is again freely available.

United States Rubber Company has developed a textile treating resin which eliminates the use of starch and still imparts a crispness to cotton fabrics. The resin is now commercially available to textile finishes, and is applied at the time of manufacture. The company also displayed a chip-proof permanent white enamel for refrigerators, washers and other kitchen appliances.

A plastic contact lens which can be mass produced, fitted and worn as easily as ordinary spectacles was shown by one company. In this connection, it may be stated that a manufacturer proposes to market plastic lenses for only thirty cents (about one rupee) a pair, in the very near future. They claim to have avoided the scratching difficulties by impregnating on the surface a thin film of silicone fluid whereas the deformation and softening due to heat has been prevented by inducing cross-linkage in the acrylate polymer.

Amongst products which bewilder the housewives were window screens in all colors that never have to be painted; plastic luggage light enough to lift with a finger, but strong enough to support the weight of a man; apparels and various ornaments that can be wiped clean with a moist cloth; various types of plastic toys, "plexiglass" hand carved flowers; and lastly, an artificial hand which looked and moved like a human hand.

Amongst various other sporting goods, displayed by many, one company showed fishing lines lighter than twine, but stronger than steel, and received quite an attention from the enthusiastics with that life-time hobby.

These are only a few of the great display put up on this occasion, besides the representatives of various plastic machinery manufacturers, moulders, fabricators and laminators. Broadly speaking, the plastic industry has a great future. Many of its applications which were initially thought of as only war time substitutes are proving superior to materials previously considered irreplaceable. "To be sure, they have their limitations, but the horizons of the industry are limited only by the resourcefulness and ingenuity of those in it. They firmly believe that 'Plastics make a better world'."

Present Advances

There were many advances in the plastics industry since 1945. About 20 new plastic compositions have been developed and a tremendous increase in the annual production has taken place. The following are a few of the important ones developed during the World War II.

1940: (*i*) Melamine formaldehyde, (*ii*) Ethyl celluse, and (*iii*) Vinylidene chloride. 1942: (*i*) Allyl, and (*ii*) Polyethylene; 1943: (*i*) Silicones; 1944: (*i*) High heat resistant thermoplastics such as styrene co-polymers

The speed with which this industry is growing will be evidenced from the fact that only during the month of March, 1946, no less than four startling announcements were made by different companies. They are (1) All wool suits that will be cool in warm weather can be made by using Resloom—a melamine formaldehyde resin, a Monsanto Chemical Company product. (2) DuPont announced new foamed plastic lighter than cork. (3) Goodyear developed a method of converting "pliofilm" into a fabric. (4) DuPont produced shatter resistant sheets of lucite acrylic resins with surface patterns formed as made.

This is only a few of which the commercial development has been found to be economical, and is expected to be on the market in no distant future.

The applications and uses of plastics underwent a revolution in the last war both by the Allies and Germany. In every part of the complex war machine, plastic products or plastic treated parts occupied an important position. The war uses of plastics ranged from buttons to navigational equipments. They included such unrelated and widely diversified items as parts of rockets, shells and bombs, in various equipments of radar, salt water purification stills, inner-soles for jungle boots, goggles, life rafts, foot-tubs, water-proof covers for small arms and equipments, numerous electrical goods, kitchen-ware and mess-gear, and innumerable packing materials.

Plastic Developments in Germany

The plastic industry in Germany is reported to have made very rapid progress during the war, and in many instances far more superior to that in U. S. A. The advances made in production and application in that country has been carefully investigated by a group of leading men in the industry of this country on behalf of the U. S. Technical Industrial Intelligence Committee. They have visited the important places of plastic research and development including the great plants of I. G. Farben - Industrie A. G. in various places of Germany, and other manufacturers. Manufacturing processes are all well advanced and great importance has been laid on the development of continuous processes. German plastic industry was as diversified or even more than in U. S., but the production is generally on a smaller scale. Among the new developments in Germany are the polyurethanes and polyvinyl ethers, besides a host of others. Polyurethanes were in use in Germany for the manufacture of fibres, bristles, adhesives, atrificial leather, injection moulding compounds, and plastic foams. The polyvinyl ethers were being used as lacquer constituents, adhesives and various impregnating agents for paper and textiles and were produced at the rate of more than 20 tons a day. The industry was confronted with a serious situation earlier in the war due to the drafting of young chemists into the Army. Ultimately, it was stopped in 1943. Nevertheless, it is of interest to note that even in spite of all these handicaps, the number of chemists working on rubber, plastics, and coating materials in I. G. plants alone increased from 291 in 1939 to 5,516 in 1943; and 243 of the latter were engaged in research!

TRAINING IN PLASTICS

P. K. CHOWDHURY,
RESEARCH CHEMIST, INDIA OIL PLASTICS LTD., CALCUTTA

IN the field of plastics industry in our country, some success has been achieved in Mysore, where with the backing of the State, the moulding factory at Bangalore has been able to produce their own Phenol-formaldehyde moulding powder but the production is so small that they are not in a position to supply others. Efforts are afoot both in Bombay and in Calcutta for the production of not only phenol-formaldehyde moulding powder but other types like cellulose acetate. The Government of India through a Directorate of Chemicals and Plastics under Dr J. N. Roy at New Delhi is issuing routine directives to the existing moulding factories, but more positive help is to be hoped for.

Complaints are often heard from Indian industrialists, keen on developing this industry that there is practically no suitable technical personnel in the country for the purpose and they have to depend entirely for the personnel on the foreign, experts. This is substantially true, for the Indian talent, has, as yet, got no chance of educating himself, as the industry itself is non-existent here. The industry is based on scientific principles of a very high order in which a continual observance of fundamental knowledge is of paramount importance in the analysis of raw materials as well as in its sales organization, in which cleanliness of factory working is in its way as important as the production of finished goods. Plastics industry is not only based on engineering excellence but also on profound understanding and requirements of the market. The industry is divided into two clear sections from the technical point of view. The raw materials section which produces the different synthetic resins and other types of Plastics and is in consequence a purely chemiical organization and a second section which buys these plastics to mould and otherwise fabricate into finished goods and is in fact an engineering organization.

There is thus a very wide range of workers in the whole plastics field. The first named section employs workers ranging from laboratory boys to charge-hands and foremen, chemists, physicists and chemical engineers in their various grades in controlling raw materials, in research, in command of research groups, or of unit and multiple processes in the factory.

Likewise the Engineering or Moulding and Fabricating branch is composed of a parallel team, those equivalent to charge-hands, working on direct moulding and forming machines, the foremen, workers on inspection of finished goods, plant and machinery maintenance engineers, drawing and design sections, often tooling departments, research and development and sometimes in the larger concerns chemists and physicists to control incoming raw materials and outgoing finished goods of specialized nature. Besides these, there are packing, stock-keeping, publicity, sales and normal office organizations.

The Institute of the Plastics Industry in Great Britain with the help of the British Plastics Federation has now set up its design for the purpose of obtaining a high standard of scientific and technical standards and has published its syllabus of educational facilities. In India too, such an Institute is urgently called for but in case, the foundation of an Institute of this type is delayed, a good beginning may be made in the existing Universities by opening Plastics Department (as being done by the Calcutta University) which may profitably adopt some of the higher courses advocated by the Education Committee of the Institute of the Plastics Industry.

The Syllabus of the Institute has been conveniently divided into two broad classes: (1) Diploma Course and (2) Associateship Course.

(1) The Diploma Course deals with Technology of Plastics Parts I and II and Engineeringg, Drawing and Mould Design Parts I and II, running for two years. The course is comprehensive and thorough and consists of knowledge in Thermo-Plastics and Thermo-setting resins in all their bearings. The Engineering Section includes a thorough knowledge of the moulding plants and casting machines, used for different types of plastics. It also deals in details with drawing and mould designs.

(2) The Higher Course or the Associateship Course consists of Diploma Course plus four other sections namely, A, B, C and D which are explained below. Of these, A is compulsory and one of B, C, D is compulsory for students appearing for Associateship Examination.

Section A.—(*i*) Fundamentals of Industrial Organisation dealing with sales, design, production, factory management, labour, etc. (*ii*) Workshop organisation and management.

Section B. Manufacture of raw materials.—(*i*) Chemistry of plastics materials dealing with natu-

rally occurring polymers and their derivatives, basic raw materials and intermediates for synthetic polymers, general chemical reactivity of polymers, etc. (ii) Physical Chemistry of plastic materials—polymer production, polymer behaviour as observed in Laboratory research, size and shape of high polymer molecules, mechanical, electrical, optical and thermal properties of polymers.

Section C. Febrication and Moulding (i) Physical Chemistry of plastics materials as already explained (ii) Physics dealing with properties of matter, heat, optics and electricity. (iii) Higher mathematics

Section D. Fabrication and Moulding (i) Engineering Tool design with special knowledge in materials (cast iron, steel, brass, etc.) metrology, machine shop practice and methods of fabrication. (ii) Materials, machines, and electrical equipments—Strength of materials, electro-technics, theory of machine and machine design.

There is also a Fellowship of the Institute, drawn from the Associate members. The qualification for Fellowship is high; a Fellow must have made an outstanding contribution to the advancement of plastics industry.

From a perusal of the above it will be apparent that the syllabus is comprehensive and very thorough dealing with all aspects of plastics industry and it is quite natural that an Associate of the Institute will be a highly qualified man fit for a very responsible post in the industry.

It may not be possible for an Indian University to give immediate effect to all the courses of the Institute so that these may be studied in the Plastics Department of the University but the course may be so amended that substantial portion of it may be adopted for the benefit of the growing industry in India.

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INDUCTION OF MUTATIONS IN YEAST BY LOW TEMPERATURES

M. K SUBRAMANIAM and B. RANGANATHAN,

DEPARTMENT OF GENERAL CHEMISTRY, INDIAN INSTITUTE OF SCIENCE, BANGALORE

As far back as 1905 Hansen observed mutations in yeasts and stated that owing to the rapidity with which the yeast passes through a number of generations, the investigator can witness remarkable transformations in a limited period. The occurrence of a top yeast as a mutant in active cultures of a bottom fermenting brewery strain treated for 60 days with acenaphthene (Subramaniam and Ranganathan, 1946) and the similarity of the above observations with that of Hansen (1905, 1907) on bottom yeasts kept at 0·5°C for 3 to 5 months tempted us to repeat Hansen's experiment with our control strain. Though Hansen believed that low temperatures merely exerted a selective influence, the rapid advances in cytogenetics of higher plants since Hansen's time (Dermen, 1938, 1940) indicate that cold treatment is not merely selective but does produce other changes and that these changes are comparable to those produced by polyploidizing agents.

A flask half full of wort was inoculated with a loop of the brewery strain (Sc., 0, N.C.T.C., 3,007) and was transferred to the ice room on 13-7-1945. At the end of every month the contents were well shaken, most of it discarded and fresh wort was added. On 10-10-1945 a sample from the flask was inoculated into a tube of wort which at the end of 24 hours showed two distinct layers, one at the bottom and the other at the top. The contents of the tube were therefore well shaken and a sample plated out. The wort agar plates showed four distinct types of colonies when examined under the microscope ("S" and "R" forms of Fabian and McCullough, 1934). There were opaque colonies with regular margins composed of big (fig. 3) and small cells (fig. 2) and colonies showing mycelial-like growths at the margin (figs. 4 and 1), one of which showed profuse branching (fig. 1).

The isolated colonies were therefore inoculated into tubes of wort and their behaviour was watched. Measurements of the control on agar slants as well as in 24 hour wort cultures, and that of the mutants on wort agar as well as 24 and 48 hour wort cultures were observed. Below are tabulated the observations and measurements of a representative series of cells composing the different strains.

	Shape in Wort-Agar	Shape in Wort	Nature of Layers observed.		
			24 hour 26-10-1945	24 hour 27-10-1945	48 hour 29-10-1945
1.	Round big cells	Mostly round	Bottom	Bottom and a thin layer at top	Bottom and a thin layer at top
2.	Round small cells	Spherical to oval	Top	Top	Top
3	Long cells	Mostly long and oval. Some spherical	Top	Top	Top
4	Long cells—profusely branching	Spherical to oval	Top	Top	Top

CONTROL STRAIN

Wort-Agar ..	Length in μ ..	5·0	6·0	6·0	6·0	7·0	7·0	7·0	8·0	8·0	9·0
	Width in μ ..	5·0	6·0	6·0	6·0	6·0	6·0	7·0	6·0	8·0	7·0
24 hour Wort ...	Length in μ ..	5·0	5·0	5·0	5·0	5·0	5·0	6·0	6·0	7·0	7·0
	Width in μ ..	4·0	5·0	5·0	5·0	5·0	5·0	5·0	6·0	5·0	6·0

ROUND BIG CELLS

Wort-Agar ..	Length in μ ..	6·0	7·0	7·0	7·0	8·0	8·0	8·0	8·0	8·0	10·0
	Width in μ ..	6·0	6·0	6·0	7·0	5·0	5·0	6·0	7·0	7·0	5·0
24 hour Wort ..	Length in μ ..	4·0	5·0	5·0	5·0	5·0	5·0	6·0	6·0	7·0	7·0
	Width in μ ..	4·0	4·0	4·0	5·0	5·0	5·0	6·0	6·0	5·0	5·0
24 hour Wort ...	Length in μ ..	5·0	6·0	6·0	6·0	6·5	7·0	7·0	7·0	7·0	8·0
	Width in μ ..	5·0	4·0	5·0	6·0	6·0	6·0	6·0	6·5	7·0	8·0
48 hour Wort ...	Length in μ ...	2·0	3·0	5·0	5·0	6·0	6·0	6·0	7·0	7·0	8·0
	Width in μ ..	1·5	1·5	5·0	5·0	5·0	5·0	5·0	3·0	6·0	5·0

SMALL CELLS

Wort-Agar ..	Length in μ ..	3·0	3·0	3·5	4·0	4·0	4·0	4·0	5·0	5·0	..
	Width in μ ..	2·5	3·0	3·0	2·5	3·0	3·0	4·0	2·5	2·5	..
24 hour Wort ...	Length in μ ..	2·0	2·0	3·0	3·0	3·0	3·0	3·0	3·5	4·0	4·0
	Width in μ ..	2·0	2·5	2·0	3·0	3·0	3·5	4·0	3·0	2·5	3·0
24 hour Wort ..	Length in μ ..	3·0	3·0	3·0	4·0	4·0	4·0	4·0	4·0	4·0	5·0
	Width in μ ..	2·0	2·5	3·0	2·0	2·0	2·5	3·0	3·0	3·0	3·0
48 hour Wort ...	Length in μ ..	2·0	2·5	2·5	3·0	3·0	3·0	4·0	4·0	4·0	8·0
	Width in μ ..	1·5	2·5	2·5	2·0	2·5	3·0	2·5	3·0	3·0	3·0

LONG CELLS PROFUSELY BRANCHING

Wort-Agar ...	Length in μ ...	9·0	10·0	11·0	12·0	14·0	14·0	15·0	16·0	17·0	18·0
	Width in μ ...	2·0	2·0	2·0	2·0	3·0	3·0	3·0	3·0	2·0	4·0
24 hour Wort ...	Length in μ ...	2·0	2·5	3·0	3·0	3·0	3·0	3·5	3·5	4·0	4·0
	Width in μ ...	2·0	2·5	2·0	2·0	2·5	3·0	2·5	3·0	2·5	3·0
24 hour Wort ...	Length in μ ...	2·0	2·0	3·0	3·0	3·0	3·0	3·0	3·0	4·0	4·0
	Width in μ ..	2·0	2·0	2·0	3·0	3·0	3·0	3·0	3·0	3·0	3·0
48 hour Wort ...	Length in μ ...	2·0	2·5	2·5	3·0	3·0	3·0	4·0	4·0	4·0	4·0
	Width in μ ...	2·0	1·5	2·0	2·0	2·0	2·0	2·0	2·5	3·0	3·0

LONG CELLS

Wort-Agar ...	Length in μ ...	3·0	3·0	3·5	4·0	5·0	10·0	10·0	11·0	12·0	13·0
	Width in μ ...	2·0	2·5	3·0	2·0	3·0	2·0	2·5	2·0	3·0	3·0
24 hour Wort ...	Length in μ ...	3·0	4·0	5·0	5·0	6·0	6·0	6·0	7·0	8·0	...
	Width in μ ..	3·0	2·0	2·0	2·0	3·0	2·0	2·5	2·5	2·0	...
24 hour Wort ...	Length in μ ...	4·0	4·0	5·0	5·0	6·0	6·0	6·0	7·0	8·0	10·0
	Width in μ ...	2·0	2·5	2·0	4·0	2·0	2·0	2·0	2·0	2·5	2·0
48 hour Wort ...	Length in μ ...	3·0	5·0	6·0	7·0	7·0	7·0	7·0	8·0	13·0	13·0
	Width in μ ...	1·5	2·5	2·0	2·0	2·0	2·5	2·5	2·0	2·0	2·0

A comparison of the figures and measurements with the observations on acenaphthene treated material (Subramaniam, 1945, Subramaniam and Ranganathan, 1946) shows a remarkable similarity. By both treatments big, small and long cells were obtained. The long-cell colonies in material treated

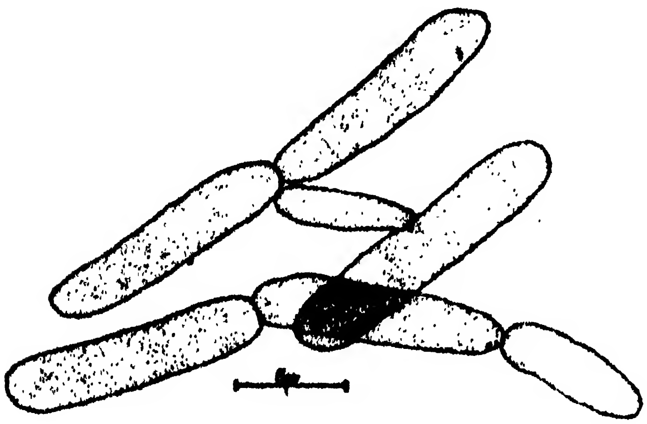

FIG. 1 Cells from profusely branching long cell colony

in these two ways had a myceilal-like margin in agar plates. Such cells produced by acenaphthene treatment reverted to an oval to round shape. In the cold treated material the long cells which showed profuse branching have almost completely reverted while the other type does not exhibit any tendency to reversion. Reversion appears to be a common phenomenon as evidenced from the reports of several

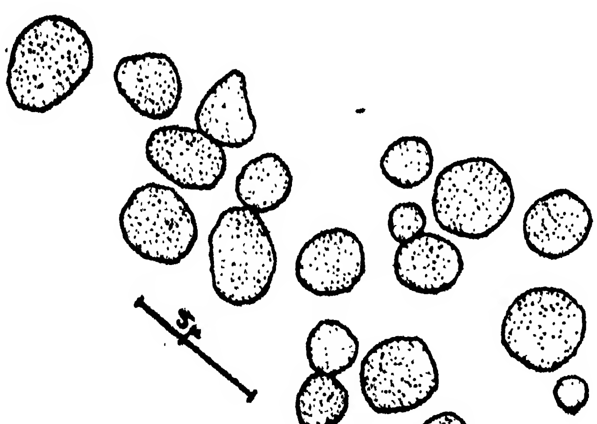

FIG. 2. Cells from small cell colony.

authors (Fabian and McCullough, 1934, Nadson, 1935, and Henrici, 1941). Actually therefore, cold treatment has produced three distinct mutations: big bottom fermenting cells, oval-to-long top fermenting cells and small round-to-oval top fermenting type. The measurements and observations indicate that the big cells are throwing out small cells. The similarity of the mutations occurring in cultures treated in different ways suggest that such mutations ought to occur in Nature and that one is merely witnessing an acceleration of the process (Goldschmidt, 1920; Randolph, 1941 and Plough, 1942.)

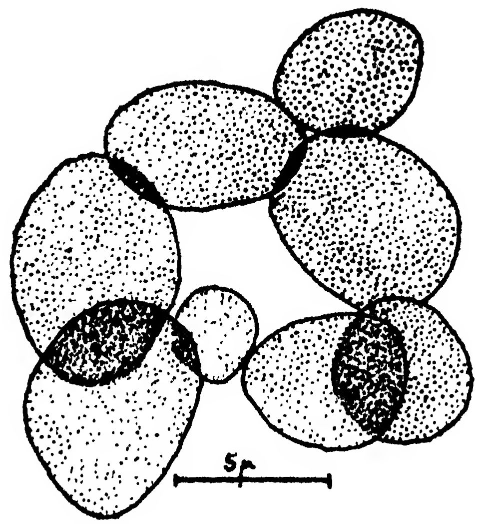

FIG. 3 Cells from round big cell colony.

Whether these are merely gene mutations or the result of structural or numerical changes in chromosomes and whether these types have a balanced chromosome constitution can only be judged after careful cytological investigations.

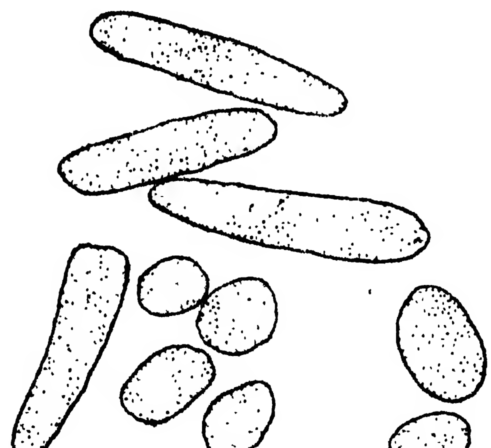

FIG. 4 Cells from long cell colony.

While these experiments were in progress the latest contribution of Prof. Winge (1944) on Segregation and Mutation in Yeasts was received. Prof. Winge comments on the remarkable lability of the *Saccharomycetes* and the very frequent occurrence of mutations which complicate protracted experiments on individual strains. He arrives at the conclusion: "The brewer's yeast types have to be looked upon

as brought about by continuous selection of mutants which continually have become increasingly suitable for industrial purposes. Through mutation most of these types have lost the capacity for sporulation. Hence it will be necessary to commence an improvement of the spare forming types under utilization of their natural tendency to mutation if we wish to take advantage of similar improvement through crossing as is employed for the higher cultural plants."[8]

* We are very grateful to Sir J. C. Ghosh, Kt., D.Sc., F.N.I., for his active interest and encouragement and to the Council of Scientific and Industrial Research for generous financial assistance.

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OBITUARIES :

PAUL LANGEVIN (1872-1946)

The death of Paul Langevin, the famous French physicist and fighter for social justice and intellectual liberty, in December 1946, has been made the occasion for several gatherings both in France and in England, where tributes were paid to his memory by leading British and French scientists and public men. To outside students of science, he will be remembered chiefly as one of the three French physicists—Curie, Weiss and Langevin—who were pioneers in the experimental study of magnetism on a quantitative basis, and in the theoretical interpretation of para- and diamagnetic phenomena on the classical electron theory. Curie also was the pioneer in the study of piezoelectric effect in quartz on a quantitative basis, and Langevin utilized his findings for the production of ultrasonic vibrations under water for the detection by echosounding method of submarines. The method which was just emerging from the developmental stage towards the end of World War I, was further developed as the Asdic during World War II for defensive and offensive underwateroperations. Peizoelectric oscillations have found important applications in electronics, acoustics and other fields. The principle of echo detection has found successful applications in the exploration of ionospheres and in the radar.

Langevin was born in Paris in 1872 of poor parents, and was educated in the Ecole de Physique et de Chimie, where his teachers included famous men like Brillouin and Pierre Curie, whom he afterwards succeeded as Director of the School. From there he secured a scholarship which enabled him to proceed to Cambridge in 1897 and work under J. J. Thomson ; he had as his contemporaries, Rutherford, Townsend and C. T. R. Wilson. At this period, following the discovery of X-rays by Roentgen, J. J. Thomson and his research students were busy in establishing the properties of the electron, which is released by X-rays and other radiations from gases and other substances. A side line to this was the study of the phenomenon of ionization in gases produced by X-rays. Langevin's investigations were on the mobilities and recombinations of the ions. His thesis on this subject was published in 1902.

The experimental investigation by P. Curie (1895) had shown that the variation with temperature of the susceptibilities of paramagnetic gases O_2 and NO could be well represented by $\chi = A/T$. In addition, it was known that all substances possess a diamagnetic susceptibility of negative sign, which is independent of temperature. Since the time of Ampére it was assumed that the magnetic phenomenon was due to closed electric currents flowing through atoms ; it was Langevin's great contribution to translate it in terms of motion of electrons in closed atomic orbits and also to quantitatively account for both the diamagnetic and the paramagnetic susceptibilities, including the temperature dependence of the latter. In this theory it is assumed that atomic electrons move in closed circuits, each of which is equivalent to a magnetic sheet. In a non-magnetic monoatomic gas, the resultant of these electronic moments is zero, and in an external magnetic field the induced diamagnetic susceptibility is a consequence of Lenz's Law. Langevin's formula for diamagnetic susceptibility enables an estimation of

average radii of the atomic electrons, and has been made the basis of a large number of experimental determinations.

To account for Curie's Law of Temperature Variation of Paramagnetic susceptibility, it was assumed that the resultant magnetic moments of electron orbitals in a gas molecule is not zero, and such molecules try to align themselves parallel to the direction of the applied magnetic field, but are thrown out of such alignment by molecular collisions. The resultant magnetic moment as function of temperature is expressed by the famous Langevin's equation, from which Curie's Law is deducible as a first approximation. This has been the starting point in the study of what are known as cooperative phenomena in solids and liquids, an instance of which is Debye's application to the study of temperature dependence of electric susceptibility of polar molecules.

His other contributions were in the theory of relativity and quantum theory, in which Langevin contributed largely to the theoretical clarification of the subjects. Independently of Einstein he put forward the Law of Equivalence of Mass and Energy.

Since the time of the famous Dreyfus trial, when the question of the guilt or innocence of an obscure artillery officer of Jewish origin threatened to split the political life of France, Langevin has always been in the forefront in the fight against political injustice. Speaking of it later he said 'those were happy days, when the fate of a single man was so valuable as could excite the whole mankind'.

Langevin was one of the founders of Comite de Vigilance des Intellectuels Anti Fascistes and after the Fascist riots in Paris in 1934, he also took an important part in the formation of the Front Populaire. As a result of all such activities, he was a marked man after the German occupation of France. He had courageously refused to leave France, though he might have easily done so, and he was arrested by the Gestapo as the most representative of all the intellectuals who had fought against Hitler. He was released from prison partly as a result of the protests of French students and professors, but he was kept under confinement at Troyes, from where he was rescued after some years by the Resistance movement and smuggled into Switzerland. His family also suffered severely from the Nazis. His son-in-law Solomon was shot for his part in the Resistance movement, and his daughter Helena was sent to the notorious death camp at Auschwitz, from which however she managed to escape. After the liberation of France, Langevin returned to Paris, where at a meeting held in the Sorbonne, homage was paid to him not only by the French intellectuals, but also by the people of Paris and the fighters of the Resistance movement. The last task of his life was the reform of education. We are indebted for information regarding his non-scientific activities to an article by Bernal which appeared in a recent issue of *Nature*, from which following quotation, embodying Langevin's social ideals is taken. "The final objective would be to find for the individual in the human society his rightful place in every respect. Society will then appear to every one of its members as a living entity in which each of us is entrusted for a while with the treasure of civilization acquired by our ancestors at the price of innumerable hardships and pains, which it is our duty to pass on, after enriching it according to the extent of our ability. . . . . Let us hope that every child, on leaving our schools of tomorrow, will be convinced that the two moral sins of conformity and selfishness respectively oppose the double imperative duty of personal achievement and social solidarity".

D. M. B.

PIERRE WEISS (1865-1940)

THE death of Langevin recalls the passing away in November, 1940 of another notable French investigator of magnetism, about which no information was available at that time. Weiss was an Alsatian by birth, having been born in Mulhouse in 1865. Partly due to German occupation of Alsace, he had to spend most of his early and middle period away from his native home. He studied engineering in Zürich and later he entered the Ecole Normale Superieure in Paris. His interest in magnetism was aroused by the study of Ewing's book. In 1896 he presented his doctorate thesis based on the study of magnetite. In 1903 he was appointed to the Chair of Physics in the Polytechnic Institute at Zürich, which he occupied with a couple of year's interruption till 1918. During World War I he was attached for some time to the Direction des Inventions, Paris, and had at that time expressed a desire that should the French regain Alsace-Lorraine he may be offered the Chair at Strasbourg. When the offer came, he immediately resigned his Zürich post and arrived in Strasbourg almost with the French army of reoccupation. Here he had a very large Institute at his disposal, and he had to spend sometime in re-

equipping and modernizing the Institute. When the writer visited Strasbourg in 1928, Weiss had a number of able collaborators amongst whom were Olliver (magneto optics), Forrer (ferromagnetism), Foex (paramagnetism), Hocart (X-ray), Ribaud (high frequency) and Bauer (mathematical physics). Weiss retired from the post of director in 1930 but continued his experimental work till 1939. He then retired to Lyons where he died in November, 1940. Weiss was a first rate experimentalist, an extremely kind man, a very good linguist, who could talk equally fluently in French, German and English. It transpired during the course of a conversation, that when Sir J. C. Bose lectured before the French Physical Society on his electric wave apparatus, Prof. Weiss acted as his interpreter.

Weiss is chiefly known for his investigations on ferromagnetism and paramagnetism. In course of these investigations he came to the conclusion (1911) that the atomic moments of the substances para as well as ferromagnetic could be expressed as multiple of a unit of magnetic moment the Weiss magneton. It was later replaced by Bohr's magneton which is a fundamental unit with theoretical justification and is within one per cent five times the Weiss unit. Weiss told the writer, that he was led to it by the then recent discovery of the unit of electric charge, and by the use of a slide rule he arrived at the greatest common factor in the measured atomic magnetic moments, which we took to be the unit magneton. After Bohr's magneton was well established, even till recently all experimentally determined magnetic moments were expressed in terms of Weiss's unit.

Weiss commenced his investigation with ferromagnetic crystals like magnetite, pyrrhotite, a ferrous sulphide with very large differences in the values of susceptibilities along the three crystalline axis. In 1907 he showed that the magnetic properties of ferromagnetics can be interpreted in terms of Langevin's theory, if the assumption is made that the total magnetic field at any point inside the crystal is taken as equal to H+kM, where H is the external field and M the molecular field, arrising out of the distribution of the neighbouring magnetic atoms and k is a proportionality factor. By various experimental methods, like magneto caloric measurements, discontinuous change of specific heat near the critical point, etc., he made several estimates of the molecular field energy and of the saturation value of the magnetic moments. The difficulty in theoretical interpretation arose when it was found that the proportionality constant k was of the order of 10^4. It was Debye who first made the suggestion that the molecular field was of electrostatic rather than of magnetic origin. Finally Heisenburg interpreted the ferromagnetic molecular field as due to quantum mechanical exchange forces between the outer electrons in a magnetic atom with those of its neighbours.

Weiss's other great contribution was the quantitative interpretation of the temperature variation in the susceptibility of paramagnetic compounds, which he showed could be represented by a slight modification of Curie's equation $\chi = \frac{A}{T-\Delta}$ where Δ is the correction term due to magnetic interaction between neighbouring atoms. Δ could have both positive and negative values. For the former for $T<\Delta$, the substance should show ferromagnetic properties, a conclusion which is not universally true. Δ is found to vary with the nature of the anion and of the non paramagnetic dilutant atomic groups. Here again Debye suggested that the molecular field was of electrostatic origin, a conclusion which has found support from the quantum mechanical investigations of Van Vlack and others, who attribute it to the splitting up of the orbital moments of the paramagnetic ions in a crystalline field of electrostatic origin.

D. M. B.

Notes and News

MINISTERIAL PORTFOLIO OF SCIENTIFIC RESEARCH

Pandit Jawaharlal Nehru is probably the first Prime Minister of a State who has specifically included 'Scientific Research' in his portfolio. It augurs well of the country which has appointed Pandit Nehru at the helm of affairs. This means that science finds a distinction in the administrative 'machinery' of the country and indicates a good beginning in the new set-up of things. We feel that since science and technology have entered intimately into the organization of a modern society, not only science be given a high rank in the formulation of policies but also the directive for work; and executive authority to translate scientific researches into social activities must be delegated to men with real scientific talent and training. We would restress that there has been in the past very unwise acquiescence in adorning members of the Indian Civil Service with all available knowledge of laws and constitution down to agricultural farm management and hydro-electric dam construction. We had the experience of metamorphosis of persons from a Sessions Judge to Director of Industries and Director of Agriculture; and ending as a Departmental Secretary. In scientific matters policies must be initiated by competent persons knowing full implications and inter-relations and the execution must be also at the top level by a scientific team who may be assisted by the efficiency of a 'Civilian'.

We believe the creation of a separate portfolio of Scientific Research will now remove the many anomalies in the scope and functions of the different portfolios under each Minister leading to duplication and waste of efficiency and speed. There are the scientific surveys like Geological, Botanical, Zoological, Archaeological and Anthropological, scientific services like, Meteorological, Agriculture, Forest, Health and lastly construction projects for development of power, transport, communication, etc. When a new beginning is being made, it is necessary to bring about a co-ordination and integration in certain cases, and the primary task is to draw a line between scientific research projects and immediate development or extension services. It has been reported in the Press that Planning and Development Department will be revived under the care of Dr Ambedkar, to whom as Labour Member (scope and nomenclature of the department were paradoxical) much credit goes for the Damodar Valley Authority. But we repeat that a permanent Planning Commission with full time secretariat is the need of the hour and this will be the chief advisory body for scientific research and recommend the priority of works and projects. The Department may have the authority to implement the measures by men drawn from scientific (including technological) fields. Prime Minister Pandit Nehru in the beginning must have an eminent scientist as his personal scientific adviser to secure the best assistance of the scientists in building a new society and a new State.

CENTENARY OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The American Association for the Advancement of Science, which corresponds to the Indian Science Congress Association will celebrate its centenary in 1948. In 1848, when the Association was organized, science consisted of two general divisions, natural philosophy and natural history, the former including the physical sciences then existing, and the latter the biological. In fact, the Association was a successor to the 'Association of American Geologists and Naturalist', established in 1842.

The Association has now 15 sections and 200 affiliated and associated societies that together cover practically all the different fields of pure and applied science. There are now more than 32,000 members, and the membership of the affiliated societies (including duplications) is probably a million. Membership in the Association is open as with the other sister organizations but there are two principal classes, "annual members" and "fellows". Members who have made a meritorious contribution to science are elected to fellowship which has the extra privilege of holding office in the Association.

In addition to conducting meetings and conferences of those interested in the various branches of science and education the Association edits and publishes two journals, besides issuing technical symposium volumes periodically. It also administers, gifts and bequets, provides support for research, arranges awards for scientific achievements, co-operates with other organizations for the advancement of science.

The Officers for 1947 are: Harlow Shapley (*President*), James B. Conant (*retiring President*), Edmund W. Sinnott (*President elect*). The present sections of the Association are: Mathematics, Physics, Chemistry, Astronomy, Geology and Geography, Zoological Sciences, Botanical Sciences, Anthropology, Psychology, Social and Economic Sciences, History and Philosophy of Science, Enginnering, Medical Science with subsections on pharmacy, Agriculture and Education.

The weekly journal *Science* was started by Thomas A. Edison more than 50 years ago and has been an official journal of the Association since 1900. The *Scientific Monthly* is an illustrated non-technical journal for the presentation and interpretation of all fields of science to the intelligent public. Members of the Association may receive both *Science* and *The Scientific Monthly* for $3.00 per year, in addition to their annual dues of $5.00.

Dr Harlow Shapley in a message on the occasion states:

"We are in these days witnessing the first hopeful, tumbling steps of the greatest biological organism yet conceived on this earth, the United Nations. These are its babyhood days, the earliest youth of a colony of 2,000 million beings. Among the professional caretakers we see a natural tendency to train the developing organization in the patterns of the past. But science and technology have now deeply entered the social structure into which the United Nations is born. The scientists and engineers of a technological civilization have begun to integrate social and scientific procedures. They have also created for themselves a momentous duty to world society, and should not scorn to help in the nursery.

It is impossible to plan for the future growth and programmes of the United Nations without being continually aware of the new relations of science to society and to human security. The security we seek is not only protection from the stupidity of war, but assurance that our civilization will not recede or stand still. Our American Association is not primarily for the Preservation of Science but for the "Advancement of Science".

"More consciously than ever before we should pursue our researches with a realization of their implications in international, as well as domestic affairs. The evolving of the United Nations during this next decade will not suddenly introduce revolutionary activities into the habits of scientists. Our operations and ideas have long been indifferent to national boundaries. Now, however, we must be more articulate in showing that scientists find that co-operation is simple, pleasant, and profitable, and that the diplomats could advantageously study our success, as could also the traders and social planners. In scientific fields co-operation can be on the scale of a campus, or a region, or a nation, or a planet. In political fields co-operation between nations is still an unfinished problem, and here the sciences can perhaps show the way. At least they can break the trail through natural obstacles, and this trail-making is one of the several responsibilities that the A.A.A.S., and its affiliates, must assume."

The Association will celebrate its centenary at its forthcoming Chicago meetings from December 26 to 31, 1947.

ISOTOPES IN BLOOD CIRCULATION

RADIOACTIVE iron and iodine have made possible a study of shock and have provided new knowledge about blood circulation. Red blood cells were tagged with two kinds of iron and blood serum albumin tagged with radioactive iodine. Report from works at Harvard Medical School reveals that regardless of cause, during shock red blood cells get trapped in the tiny blood vessels in all organs of the body. Evidently treatment of shock should be devoted not only to restoring the total volume of blood in the body but also towards starting the blood flowing again in the capillary blood vessels. The present method of studying blood circulation is by the use of a blue dye and by centrifuging a sample of blood and measuring the mass of red cells collected at the bottom of the tube. Persons who had haemorrhages showed discrepancies in the results by the above methods.

TRANSPLANTATION OF EGG CELLS

IN experiments at Worcester Foundation for Experimental Biology in Massachusetts, U.S.A., egg cells from female rabbits have been extracted and stored at temperatures ranging from 32°F to 50°F for period of from 24 to 168 hours. Then they were warmed up to normal body temperature and kept for 24 hours. Cell division occurred in many of the primary cells and those showing normal cleavage were transplated into the foster-mother bodies. Part of these have developed into normal rabbits in due time. Best results were obtained with eggs cells that had been kept at 50°F. These 'refrigerator rabbits' are a step towards production of more and better livestock. 'Test tube' experiments had no time-lag and fresh egg cells taken from the mother animal's body were immediately transplanted into another female for fertilization.

ATOMIC ENERGY BOARD

A BOARD of Research in Atomic Energy has been set up under the auspices of the Council of Scientific and Industrial Research, consisting of Prof. H. J. Bhabha (chairman), Dr Nazir Ahmed, Sir S. S. Bhatnagar, Dr M. S. Krishnan, Prof. M. N. Saha and Mr D. N. Wadia. A joint committee consisting of six members of the board and three representatives of the Travancore Government *viz.*, Mr V. Mahadevan, Mr K. P. Menon, and Dr K. L. Moudgill, will advise the two governments on all matters connected with research and development and the disposal and utilization of raw materials.

This joint committee will be the authoritative advisory body for both the Governments of India and Travancore, thus bringing this important branch of power research and disposal of raw material into one co-ordinated scheme.

Announcing the setting up of the Board, Mr C. Rajagopalachari, Minister for Industries, Government of India now His Excellency Sri Rajagopalachari, Governor of West Bengal in a statement said that the public may rest assured that the atomic energy resources of India will not be frittered away or go to waste. Continuing he said, "It would be a mistake, let me say in this connection, to associate atomic research only with destructive activities. India has no desire to destroy. The power to explode and destroy is only a symptom of available energy which waits to be handled by scientific research for the purposes of constructive utilization."

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

A meeting of the Governing Body, CSIR, was held at New Delhi, on August 25 last, Pandit Jawaharlal Nehru, F.N.I., Minister, Scientific Research (president, CSIR), presiding.

Addressing the meeting Pandit Nehru said: "Before long we shall consider planning in various forms and then your advice would be valuable. We shall have to go at a faster speed. After a big change we have to face a large number of problems." Referring to the communal problems in the Punjab, he said, these problems have to be tackled not in an emotional, but in a scientific way.

The Council sanctioned the following schemes of research involving a total expenditure of Rs. 83,700: Study of formation of vortices in solar atmosphere by Dr S. K. Banerji; x-ray investigation of coal by Prof. K. Banerji; preparation of new anti-malarials by Dr P. C. Guha; ultrasonic velocity in gases and vapours by Dr S. K. K. Jathkar; manufacture of industrial catalysts by Dr J. C. Ghosh; manufacture of potassium permanganate by Mr G. C. Mitter; antibiotics by Col. S. S. Bhatnagar; and cultivation and improvement of medicinal plants by Brevet-Col. R. N. Chopra.

The Council further granted a sum of Rs. 3 lakhs for the Research Institute of the Indian Academy of Sciences, Bangalore, for physical and chemical investigations of the minerals of India under Sir C. V. Raman.

Dr S. P. Mookerjee, Minister, Industries and Supplies was elected Vice-President of the Council.

MEASUREMENT OF GLOSSINESS

The glossiness of a surface is a complex phenomenon depending upon both objective and subjective factors. Numerous attempts to measure gloss by instrumental means have been found to be inadequate. Most of the methods consist in analyzing light reflected from the surface by photometer or other means. Some elaborate methods involve exploring polar distribution of intensity, while a further group attempts to relate gloss to the degree of polarization produced by surface reflection; but the evaluation of different instruments differ widely and exhibit serious discrepancies. The evident difficulty of surmounting even the material or objective elements of gloss measurement is a good indication that to solve the problem account must also be taken of the physiological and psychological factors.

Recently Dr V. W. Harrison, of 'Printing and Allied Trades Association' has published a remarkable treatise on this subject—"Definition and Measurement of Gloss". Not only does this treatise summarize for the first time a mass of information hitherto scattered over papers and periodicals but it adds thereto the original thought on the part of the author. Dr Harrison wisely restricts his attention to the visual sensation of gloss, which, he concludes, is an exception closely bound up with the various ways in which light is reflected from the surface viewed. He commended Barka's method to analyze the reflection characteristics of a surface in terms of an optically equivalent distribution of reflecting and diffusing facets as highly significant achievement. From a thoughtful consideration by himself and other observers Dr Harrison reaches the conclusion that visual impression of gloss is bound up with binocular vision. Photographic prints, viewed through a a stereoscope, appear more glossy. Black and white striped cloth appear more lustrous due to binocular vision of unaided eye. Appearance of velvet partly depends on visual indefiniteness about the exact situation of the surface (*i.e.*, impression of seeing simultaneously two sources of light one slightly more distant than the other). Dr Harrison contends that the appearance of a surface is judged by sensation, or, more precisely, by sense data. He holds that the relevant agencies reside in the borderland between the material and the mental. The sensation received by looking at a glossy surface depends on, and is part of, a collective perception which includes all associated sensation in a particular order of arrangement. A change in any factor, even it be external to the glossy surface, alters in some measure the sense perception. This is not a new concept. It is of great importance as expressing the most outstanding and fundamental difference between the mechanical materialist outlook of nineteenth

century science and the more enlightened approach of modern physics. (*Engineering*, May 30, 1947.)

MODERN CIVIL ENGINEERING AND GEOLOGY

THE increasing number of dam construction and extensive use of concrete have necessitated intimate study and knowledge of geology, especially of petrography. Before the construction of dam, full knowledge of geological character of both upper and lower strata of the dam site must be acquired. Very often causes and potentiality of land slide, the different kinds of materials exposed on the edges of the reservoir should be measured and mapped. The study of reactions between cements and concrete aggregates and extensive research to determine the kind of rocks which are susceptible to high alkali cements and developments of standard methods of petrographic and micro chemical study of rocks have all become an imperative necessity.

It has been generally recognized by the leading geological societies that the present university curricula are inadequate to train men to extend their geology into engineering applications. Geologist must some how achieve in addition some understanding of engineering concepts and methods. Engineers are concerned less with the origins and composition of rocks, soils and landscape than their actual physical behaviour under the condition of engineering service. In fact, engineering geology should be recognized as an independent profession. This recognition has been accorded more freely by civil engineers than by geologists. There are indeed a host of engineering geologists but they are more geologist than engineer. Educators should try to solve this problem and recognize the urgent demand for men trained as truly engineering geologist. (*Engineering*, May, 1947.)

EXPANSION OF FIBRE INDUSTRY IN INDIA

WE note with interest that a panel appointed by the Central Government in respect of industries related with coir, rope, cordage and other fibre in a report published recently has urged for the improvement and expansion of cocoanut cultivation and for stepping up the production of coir in India. The panel points out that India has extensive uncultivated areas suitable for large-scale Sisal plantation as their climate is similar to that of East Africa. The damp-resisting quality of sisal fibre will play an important part, in the manufacture of rope and cordage and of cheap floor coverings. The panel, therefore, recommends the cultivation of such industrial fibro plants in India with the aid of up-to-date machinery.

In the opinion of this panel, there is no serious rival to coir (a fibre obtained from the fibrous pericarp of cocoanut) as a hard fibre at present. Coir may largely be used in the manufacture of mats and matting. Coir when properly treated, resists decay by bacteria and water and can be easily impregnated with bituminous and resinous materials. A target production of 220, 125 tons of coir involve improved and mechanical methods in the retting of husks, and proper grading of fibre is also emphasized. India should make fuller use of the raw materials by retting all available husks and by establishing roperies in Travancore, Cochin, Malabar and Bombay, so as to absorb more coir. Increased use of synthetic fibres has further to be carefully watched.

The establishment of a 'Coir Textile Institute', as envisaged by this panel, appears to be essential. In the establishment of this institute, Government should organize research in close co-operation with the universities and industrialists.

Import of duty-free manila and sisal fibre, a tariff on imported rope, and financial assistance to the industry for research purposes, reduction in the tariff imposed by countries importing coir mats and matting appear to be reasonable demands, should the Indian fibre industry thrive. In the editorial of the present issue the subject of fibre industry in its wider aspects has been reviewed.

AFFORESTATION OF DRY AND ARID AREAS

THE great Indian desert of Sind and Rajputana, which covers about 100,000 sq. miles with desert conditions extending round it for another 100,000 sq. miles—comprising nearly 1/6th of India's surface—has been fanning outwards to the north and east, at the rate of about half a mile per year over the last 50 years, according to *Indian Forest Bulletin No. 133*, issued by Forest Research Institute, Dehra Dun. This means, approximately 300 sq. miles of fertile land are being converted into desert every year.

Apart from this spread of desert very serious soil erosion is occurring in many parts of the country. There is need for the country to be more "forest conscious" and if agriculture is to prosper, the total area under forest must be increased from 12 per cent to some 25 per cent.

Afforestation in dry and arid areas, which occupy nearly 1/3 to 1/2 of the country will ameliorate the rigours of climatic conditions, arrest the depredations of erosion and supply the villager with food, fodder and fuel.

The bulletin gives a list of 250 species of plants suitable from afforestation and economic points of view for dry and arid areas.

SIXTH INTERNATIONAL CONGRESS OF EXPERIMENTAL CYTOLOGY

THE sixth International Congress of Experimental Cytology, (now renamed International Society of Cell Biology, as announced earlier in SCIENCE AND CULTURE, July, 1947, p. 32) was held in Stockholm from July 10 to July 17, 1947, and was attended by about 500 delegates representing 28 countries. The Congress received about 155 communications some of which stimulated valuable discussion, notably those by Astbury, Bernal, Wyckoff and Szent-Gyorgyi. The general meeting formally approved the change of name of the society and also the revised constitution and statutes. The entry of the society into the International Union of Biological Science was unanimously ratified.

The most important feature of the Congress was the unanimous adoption of a resolution condemning, and urging the prevention of, all warfare, particularly the bacteriological and biological warfare. The full text of the resolution, as moved and seconded by Dr Runnstrom (Sweden) and Dr Lwoff (France) respectively, runs as follows:

> "Whereas an International Congress such as this, the first cytological congress to take place after a devastating war, is an expression of the peaceful solidarity of scientists and of the need for international co-operation and friendliness to ensure progress;
>
> And whereas the biologists are especially concerned with the prevention of warfare, and in particular bacteriological and biological warfare;
>
> Therefore be it resolved that the International Society of Cell Biology set up a Committee to offer technical advice, and assistance to the United Nations Organizations and its specialized agencies for this purpose; and invite the International Association of Microbiologists to form a Joint Committee with us."

It was announced that the next Congress would take place in the U.S.A. within the next two or three years. The previous Congresses were held in Amsterdam, Budapest, Cambridge, Copenhagen and Zurich.

It is of interest to note that UNESCO provided travel grants-in-aid to enable 48 scientists of eleven countries to attend the Congress.

Following are the office-bearers and members of the Committee for the ensuing year:—

President—Dr J. Runnstrom (Sweden); Dr E. Newton Harvey (U.S.A.), Dr G. Levy (Italy) and Dr E. Faure-Framiet (France). *Secretary-Treasurer*—Dr J. F. Danielli (U.K.). *Members of the Committee*—Dr H. Okkels (Denmark), Dr Honor B. Fell (U.K.), Dr Paul Weiss (U.S.A.), Dr G. C. Heringa (Netherland), Dr T. Caspersson (Sweden) and Dr A. Frey-Wyssling (Switzerland). *Representatives of International Union of Biological Sciences*—Dr D. Kostoff (Bulgaria) and Dr H. Okkels (Denmark).

FOURTH INTERNATIONAL CONGRESS OF MICRO-BIOLOGY

ALMOST simultaneously with the experimental cytologists, about 800 microbiologists from 38 different countries met in Copenhagen in the third week of July (see SCIENCE AND CULTURE, July, 1947, p. 32) to make the fourth International Congress of Microbiology a success. The Congress received some 330 communications. The four Committees—Nomenclature Committee; *Salmonella* sub-committee of the Nomenclature Committee; the Committee for Phage Typing, and a Judicial Commission on Bacteriological Nomenclature—, and the Permanent Commission for Organization of Congress, all had their meetings during the Congress.

The Congress, by a resolution carried out unanimously, secured the affiliation of the International Centre of Type Culture Collections (Lausanne) with the International Association of Microbiology. The following is the text of the resolution:

"That the Centre de Collections de Types Microbiens (Lausanne) be formally affiliated with the International Association of Microbiology, and that the Centre and I. A. M. B. be associated in the development of an International Federation of Type-Culture Collections, and of the World Catalogue of Strains Maintained".

The International Centre of Type-Culture Collections, now endorsed, implies primarily the preparation of the World Catalogue, whereas the International Federation of Type-Culture Collections, if implemented, would seem to involve decisions as to the allocation of duties. Numerous concrete suggestions for the improvement of the card catalogue were made.

INTERNATIONAL UNION OF BIOLOGICAL SCIENCES

THE General Assembly of the International Union of Biological Sciences was held on July 28, 1947 at the Royal Danish Academy of Sciences in Copenhagen. The following subjects were represented: Botany; Embryology; Entomology; Experimental Cytology; Micro-biology; and Zoology. The Assembly discussed the admission and the statutes of the newly created sections of Cell-biology, Micro-biology, Entomology and Zoology. A very

interesting discussion concerned the scientific activities of the Union in 1947-48. The following symposia have been agreed upon: Rare Elements in the Physiology of Plants (Rothamsted); Protective Insects (Antibes); Nomenclature of Genetics and Cytology (Stockholm); Growth of Nerves (U. S. A.); Interaction of eggs and sperms (Milan); Role of Anaerobes in Nature (Paris).

The General Assembly approved of the resolution of the recent International Congresses of Experimental Cytology and Micro-biology, strongly condemning the biological warfare. A resolution relating to the possible creation of a stockroom for radioactive isotopes was approved.

A Joint Commission on Radio-Biology was created by the Union. This Commission will be joined by the representatives of the International Union of Pure and Applied Physics and of the International Union of Chemistry.

The next General Assembly, it is announced, will take place in Stockholm in 1950, simultaneously with the International Congress of Botany.

UNESCO - IUBS Fellowships are available for 1947 at the Naples Zoological Station, the Roscoff Marine Station and the Central Bureau for fungus cultures of Baaru. Applications should be sent to Dr M. J. Sirks, University of Groningen, Secretary of the I. U. B. S.

DESTRUCTION OF JAPANESE CYCLOTRONS

SOME time ago, we reported in these columns (see SCIENCE AND CULTURE, December, 1945, p. 303) the distruction of the Japanese Cyclotrons by the U. S. Army engineers, working under instructions of the U. S. Military High Command in Japan. In the June 1947 issue of the *Bulletin of the Atomic Scientists*, Dr Yoshio Nishina, Director of the Institute of Physical and Chemical Research, Tokyo, gives details of destruction of his cyclotrons. At the time of the destruction, Dr Nishina and his collaborators were carrying on researches in biology and medicine, which were supposed to throw light on many important problems of agriculture, forestry, animal husbandry, fishery and medical therapy. Needless to say that, for researches on these subjects, the Institute had the previous authorization of the SCAP. This authorization was suddenly rescinded, order was served on the research workers and employees of the Institute for evacuation, and the two cyclotrons of the laboratory were destroyed, probably as a guarantee against any possible atomic agression from the Far East. Here is the story in Dr Nishina's own words:

"Under the date of October 15, 1945, request was filed with the SCAP for the permission to operate the cyclotrons in the Nishina Laboratory for the purpose of research in biology, medicine, chemistry and metallurgy. The permit was immediately granted, but it was later restricted to investigations only in the field of biology and medicine. While we were getting ready for work along the lines authorized, suddenly on November 20, the laboratory was subjected to investigation by SCAP, GHQ, and in the evening of November 22, a memorandum was transmitted through the Central Liaison Office, rescinding the previous authorizations and directing that the research be stopped. November 24, at 8-30 A.M. Major O'Hearn, GHQ., gave us the order for the destruction of the two cyclotrons in the Laboratory, one weighing 220 tons, and the other 28 tons. The destruction was accomplished in five full days, by Engineers of the 8th Army, working day and night".

"Even to-day" writes Dr Nishina, "we absolutely fail to understand the reason for ordering the destruction of the cyclotrons. We surmise that cyclotrons might be considered as indispensable for the study or manufacture of atomic bombs. This, however, we know to be a mere 'superstition' of uninformed laymen".

Besides, it is well known that Japan is deficient in uranium bearing minerals. Her industrial power, as Dr Nishina would suggest, was altogether inadequate for the production of atomic bombs, even if enough uranium was available in Japan.

The two cyclotrons were constructed through the tireless efforts of a few scores of scientists working for more than twelve years. Their destruction was one of the most glaring acts of vandalism ever committed by civilized men in the name of justice and peace. This destruction has been described as "wanton and stupid to the point of constituting a crime against mankind", and was "as disreputable and ill considered as would be the burning of Japanese libraries or the smashing of Japanese printing presses". Commenting on this, the American atomic scientists have remarked: "Men who cannot distinguish between the usefulness of a research machine and the military importance of a 16 inch gun have no place in position of authority". True, but how to prevent such men from being in positions of authority?

EIGHTH INTERNATIONAL GENETICS CONGRESS

DETAILS of the plans for the Eighth International Genetics Congress, as announced earlier (see SCIENCE AND CULTURE, July, 1947, p. 32) are now issued by the Secretary General of the Congress, Prof. G. Bonnier. The Congress will be held on July 7-14,

1948, at Stockholm with Prof H. J. Muller, N L., as President and Prof. H. Federly of Finland as Vice-President.

The seven days of the Congress are tentatively organized as follows 1. Nature of Genes. Mutations. 2. Phenotypic and other effects of structural changes within the chromosomes. Position effects. 3. Chromosome morphology and chemistry. Eu- and heterochromatin. The mechanism of mitosis and meiosis 4. Numerical chromosome changes-polyploidy, aneuploidy, accessory chromosomes. 5. Structural and other chromosomal changes in the light of the species problem and of evolution. Genetics of wild populations. 6. The effect of the genes during ontogeny. Genetics and cancer. Sex determination. Cytoplasmic inheritance. 7. Selection, inbreeding and outbreeding, genetics of quantitative characters.

Papers dealing with the genetics of animal and plant breeding and on human genetics should reach Prof. Bonnier not later than March 1948, C/o Genetics Congress, Stockholm 24, Sweden.

WORLD STATISTICAL CONGRESS

THE *World Statistical Congress*, (SCIENCE AND CULTURE, August, 1947, p. 70) and the twenty-fifth session of the *International Statistical Institute*, will be held in Washington, between September 6-18, 1947.

Accepting an invitation from the President, USA and the Secretary-General UNO, the Government of India have sent a delegation led by Prof. P. C. Mahalanobis (representative of India on the UNO statistical commission) to attend these conferences; Mr R. C. Bose, Calcutta University, Mr K B. Madhava, Statistician, Transport department, Government of India, Prof. V. K. R. V Rao, Delhi University, Dr P. V. Sukhatme, Statistician, ICAR and Mr S. Subramanian, Statistician to the Economic Adviser to the Government of India (*Secretary*) are the other members of this delegation.

Apart from mathematical subjects, problems relating to population, national income, statistical organization, etc., will be discussed at these conferences.

ANNOUNCEMENTS

PROF. F. W. LEVI, Mr S. Gupta and Prof. P. S. Gill have joined the Tata Institute of Fundamental Research, Bombay. Prof. Levi is the Hardinge Professor of Higher Mathematics in the Calcutta University, and is well-known for his work on modern algebra with particular emphasis on the theory of groups. He will deliver a course of lectures on modern algebra at the Institute. Dr Gill is well-known as one of the best workers on cosmic rays in India and will join the Institute as a Professor of Experimental Physics. He was until recently a professor at the Forman Christian College, Lahore.

Mr Gupta who is also a Lecturer in Applied Mathematics in the Calcutta University is to help in the collective effort of the Tata Institute, as Reader in Theoretical Physics for the benefit of India as a whole.

PANDIT JAWAHARLAL NEHRU has been elected a Fellow of the National Institute of Science of India.

DR A. C. UKIL, M.B., M.S.P.E. (Paris), Editor, *Science and Culture*, and for a long time a Visiting Physician in charge of the Chest Department, Medical College of West Bengal, Calcutta, is appointed Principal of the college. He conducted Tuberculosis Enquiry under the Indian Research Fund Association.

DR A. B. BHATIA of the University of Allahabad, has been awarded an Overseas Science Research scholarship for 1947 (Royal Commission for the Exhibition of 1851), for research in physics at the University of Bristol.

BOOK REVIEWS

Geology and Geography of Karachi and its Neighbourhood—By Maneck B. Pithawalla, D.Sc., F.G.S. & P. Martin-Kaye, R.A.F., Karachi, 1946. Price: Rs. 10.

We congratulate the author for bringing out this voluminous monograph on Karachi stuffed with valuable materials at a time when bringing out of books was almost impossible due to abnormal conditions. Geographers in India, so long, have practically maintained an academic detachment from the nation-building activities of the country. It is very refreshing to find that Dr Pithawalla has shaken off this aloofness and given a right bent by venturing to apply his patient researches for, what Mr Wadia observes as ' the planning and economic development of a Province". In no work of geography have we seen the geological basis so thoroughly developed and utilized as has been done in the book under review by the author. Mr Martin-Kaye, the geological collaborator of the author came here on war duty, but has left a lasting link of friendship through the valuable contribution he has made in working out the geology of Karachi and its neighbourhood amidst the various preoccupations of military duties. The second part of the book has been devoted to 'useful information about the existing conditions and the inherent potentialities of Karachi has been brought to light in a comprehensive manner.' This book has been profusely illustrated with maps, charts, pictures and diagrams. We must, however, submit that while going through the book one misses the link, so essential, amongst the different chapters so as to sustain a like interest in it. We hope that those in charge of the reconstruction of the Province of Sind will not fail in utilizing the expert suggestions offered in the book.

K. B.

Infrared and Raman Spectra of Polyatomic Molecules—By Gerhard Herzberg, Pp. xiii+632. D. Van Norstand Company Inc., 250 Fourth Avenue, New York, 1945. £2-10 net.

The book under review forms the second volume of the series on Molecular Spectra and Molecular Structure, the first volume entitled "Molecular Spectra and Molecular Structure Diatomic Molecules" being published a few years back. The present volume deals with the theoretical aspects of infra red and Raman spectra of polyatomic molecules having different symmetry elements. Starting with a description of different types of symmetry elements and point groups in the introduction, the author has given in the first chapter an account of the theory of rotational infra red and Raman spectra of linear, symmetric, top, spherical top and asymmetric top molecules. Relative spacings and statistical weights of rotational energy levels, influence of nuclear spin and statistics on the statistical weight in particular cases and selection rules for the rotational infra red and Raman spectra of the molecules have been discussed in this chapter with the help of suitable illustrations.

Chapter II is fairly long and deals with the theory of vibrations of polyatomic molecules. In the first section of this chapter the theory of normal vibrations, both nondegenerate and degenerate, has been given in detail. This has been followed in the next section by discussions on vibrational energy levels and eigenfunctions. In the third section the symmetry of normal vibrations has been explained with the help of diagrams and the method of deriving the character tables for different point groups has been discussed in detail. Eighteen character tables for different sets of point groups have also been included in this section. In the fourth section the methods for the determination of the number of normal vibrations of nondegenerate and degenerate types and for solving the secular equation have been explained. These methods have also been applied to find the frequencies of the vibrations from the masses of the vibrating atoms and the force constants in the case of molecules of known structures belonging to different point groups. The last two sections of this chapter deal with the theory of interaction of vibrations, accidental degeneracy and isotope effect. Some of the observed results have also been compared with those expected from the theory.

The classical polarizability theory and the quantum theoretical treatment of the origin of vibrational infra red and Raman spectra of polyatomic molecules have been given briefly in the first two sections of Chapter III. The selection rules for both infra red and Raman spectra of vibrational type and the intensities and polarisation of the Raman lines due to different modes of vibrations have been discussed from theoretical point of view. In the third section under the caption "Individual Molecules" experimental results regarding the vibrational infra red and Raman spectra of a large number of molecules

of different types have been discussed in relation to the theory. In Chapter IV the theory of rotation vibration spectra of polyatomic molecules has been given briefly. The selection rules for the appearance of these bands in the infra red and Raman spectra have been given for linear, symmetric top, spherical top and asymmetric top molecules and for molecules with free internal rotation. Diagrams of a large number of infra red bands and of energy levels have been included and a few beautiful photographs of infra red bands observed in the photographic region have been reproduced in this chapter. The last chapter is devoted to some particular applications of the data regarding the infra red and Raman spectra of polyatomic molecules, *e.g.*, the calculation of thermodynamic quantities and investigations on the nature of liquid and solid state. The discussions on the latter topic, however, are mainly theoretical and only some of the results observed have been included in a table

The author has made valuable contributions to our knowledge in infra red spectroscopy and it is his long experience in this line of research that has enabled him to present in a comprehensive form theoretical discussions both on infra red spectra and Raman spectra. In fact this is the only treatise in English on the molecular spectra in which both infra red and Raman spectra have been discussed with equal emphasis. Although it has not been possible to include in the volume all the details of theories, the author has spared no pains to make the discussions useful to the beginners as well as research workers. For this purpose he has started from the beginning in some cases Also numerous diagrams have been included and a few beautiful spectrographs have been reproduced. These will be of much help to the beginners. No attempt has been made to include in this volume an up to date bibliography of the work done in these lines, but the discussions in Chapter III on individual molecules are fairly exhaustive and will be much useful to research workers. The extent to which the author has strained himself in traversing the whole field of the subject can be gauged from the fact that references have been made to 978 original papers and the total number of illustrations is 174.

The book will no doubt find its place in the libraries of almost all the institutions engaged in researches on molecular spectra and allied subjects and will also be useful to post-graduate students interested in these subjects. But for the fact that some of the discussions are printed in very small types, the get up of the book is otherwise satisfactory, and considering the large number of blocks used, the price of the book seems to be highly moderate.

S. C. S.

A History of Western Philosophy—By Bertrand Russel. George Allen & Unwin Ltd. 1946. Price 21*s.* net.

A book on philosophy by Bertrand Russel is an important philosophical event. For over 40 years he has been experimenting with problems in almost every sphere of philosophy. In the course of his enquiries, he has probed into problems of Mathematics, Logic, Metaphysics, Psychology and Ethics, including in the term both private and public morality. A survey of Western philosophy by Russel is, therefore, welcome on more grounds than one.

Russel himself points out that his main interest is in the study of philosophical problems in their relation with political and social circumstances. He tends to suggest at times as if this is a virtue which is peculiarly his own and other historians of philosophy before him have neglected its socio-political background This is hardly correct. From the very nature of the case, philosophers have been compelled to take note of their current intellectual background. This has meant recognition of the socio-political factors which have shaped the thought of the age. Every historian of philosophy of any note has stated that no philosopher can be studied without reference to his predecessors as well as his immediate environment. This is one of the reasons why philosophers have been regarded as Janus-faced. One face turns backward and sums up the preceding age while the other is forwardlooking and anticipates the problems of the future.

Russel has himself recognised that a history of Western philosophy alone is bound to be somewhat incomplete and onesided. Till recently it has been the fashion to think that philosophy started with the Greeks and had its course of development in Europe alone. Recently, however, there has been some recognition of the fact that there was philosophical speculation in India as well, but generally this has been a grudging recognition. It has not yet been fully realised that all the philosophical schools which flourished in Greece had their counterparts in ancient India. In fact, Indian speculation has, in many cases, gone beyond that of the Greeks and stated explicitly what is implicit in Greek thought. Modern interpreters of Plato have to read in Plato niceties which are found fully developed in the thought of the Indian philosophers. In addition, Indian philosophy presents certain development which were not attained by even the highest reaches of Greek philosophical thought. This is particularly true of the sphere of Logic. The Indian analysis of "relations" is more subtle and acute than any to be found among the Greeks.

Russel's History also suffers because of an imperfect appreciation of the contribution of Arab thought to the development of philosophy. In common with most other European scholars, Russel is content to think of the Arabs as mere interpreters of Plato and Aristotle. Interpreters of Plato and Aristotle they certainly were and it is through their writings that the European world was reintroduced to the thought of Plato and Aristotle. Arab philosophers are, however, not mere interpreters. In certain important respects they have original contributions as well. This is particularly true in respect of the development of the concept of substance. The ontological argument has also been influenced by Arab thought. In fact, the new emphasis on empiricism and experiment which one finds in European thought from the 16th century onward cannot be derived either from Hellenic or Hebraic sources. The Islamic emphasis on the unit of phenomenon and noumenon is one of the factors which explains both the rise of modern science and the empirical bias of modern European philosophy.

Russel's book is of value in drawing attention to the contribution of Catholic philosophy to the development of European thought. This is a feature which has often been neglected in the current histories of European philosophy. The recent developments in European political thought cannot, however, be understood without reference to the contribution of the scholastics. To a certain extent, it was the influence of the school men which led to an undue emphasis upon the individual and in time led to the disintegration of "community sense" in European civilisation.

Russel's personal likes and dislikes are more apparent in his choice of the philosophers in recent times. At times he tends to be conventional. Thus, his slightly supercillious treatment of Machiavelli is in keeping with current liberal traditions, but overlooks the fact that Machiavelli"s writings contain an element of satire on contemporary society. Croce in his latest book has brought this point out in a most interesting manner. The same personal factor explains Russel's obsession with and dislike of men like Kant, Hegel or Schopenhauer. It is a little surprising to find Byron treated at such length in a work of philosophy, but here again Russel has allowed his personal reactions to influence his philosophical judgment.

Any history of philosophy is bound to be largely a presentation of the philosophy of the writer. Russel's book is no exception. It is, therefore, not surprising that he should end with the Logical Analyists with whom he has greater sympathy than with any other school. Some of the virtues and defects of logical analysis are apparent in almost all Russel's writings. He has clarity, lucidity and precision. Analysis, however, tends to deny the qualities of depth and profundity. For Russel Philosophy is, therefore, something intermediate between Theology and Science and exists only because Science has not yet been able to master the whole domain of reality. As Science advances, the realm of philosophy continually diminishes. This, however, is at best a hypothesis and, therefore, itself proves that philosophy can never be eliminated from the sphere of human enquiries.

H. K.

Wonders of Animal Migration · By F. M. Duncan, (No date ; about 1947). x + 150 pages, 13 plates. Sampson Low, Marston & Co., Ltd. London. Price 12*s*. 6*d*. net.

The subject of animal migrations is so fascinating and so full of wonders, that no apology is needed for a popular exposition of the subject, as Mr Duncan has attempted to do. The plan followed in the book is that the more startling and better known examples of migration in various groups of animals are given, followed in some cases by theoretical explanations. The latter portion is, however, weak and the author has pooh-poohed the value of theories--a wrong attitude to adopt even in a popular exposition.

The book contains no original information, being entirely a compilation. It would have enhanced the value of the book if references to the original sources had been given. There are 13 full-page plates in pencil, signed by the author, depicting the various migratory animals. The style is rather redundant and at times too ornate and forced.

The book is divided into 8 chapters whose scope is as follows: Chapters 1 and 2 deal with bird migration. It is stated, for example, that the Arctic Tern breeds in summer in the Arctic region and winters in the Antarctic region, thus traversing the two American Continents, a distance each way of 11,000 miles, or both ways of 22,000 miles, which is about equal to the circumference of the earth. Many species of ducks and geese, which winter in southern Asia, migrate to Siberia for breeding in summer. The speed of migration in various birds varies from 20 miles per hour in the smaller ones to about 60 miles per hour in the larger. Why these migrations occur every year with uncanny accuracy, is an unsolved problem.

Chapter 3 deals with land mammals. Enormous migrations which were witnessed a couple of hundred years ago, are no more to be seen owing to the wholesale destruction of wild animals by man, but a few examples are still noticeable. Thus, the Scandinavian Lemming, a small rodent which is normally a shy, retiring creature found in small numbers,

periodically (about every 10 years) multiplies enormously. Then it becomes fearless and migrates westwards in millions, heedless of any obstruction, as if goaded by a blind urge. Tens of thousands die on the way, and those that are able to reach the sea, plunge madly into it and perish!

Chapter 4 deals with aquatic mammals, reptiles and Amphibia. Chapter 5 covers migration among fishes. The European Freshwater Eel, of whose migrations nothing was known 50 years ago, has now been found to undergo extraordinary migrations. When mature, the eels leave their freshwater homes (rivers, ponds, etc.) in Western Europe and head towards the Atlantic Ocean which they cross, in order to reach a patch of ocean near the Bermuda Island, off the coast of Newfoundland. Here they lay eggs, and the young larvae, in course of 2 or 3 years, find their way back to the rivers of Western Europe. Chapters 6 and 7 deal with migrations among insects, *e.g.*, butterflies, locusts, etc., while Chapter 8 refers briefly to crabs and other marine invertebrates. This is followed by an index.

On the whole, Mr Duncan has succeeded in bringing together the salient facts of migration within the scope of a small book, and we can safely recommend it to the general public. The young university student will also find it very useful.

M. L. R.

LETTERS TO THE EDITOR

[*The Editors are not responsible for the views expressed in the letters.*]

A SIMPLE AND ELEMENTARY METHOD OF OBSERVING LISSAJOUS' FIGURES

All that is required for this purpose is a thick convex lens of about 2" diameter and a bright lamp hanging from ceiling of the semi-dark room.

The lens is placed flat on a table and position of the eye is adjusted so that the image of the lamp formed by reflection at the upper surface of the lens is seen conveniently. This image almost becomes a sharp luminous point if a highly curved lens is used. A vertical tap on the edge with finger or a pencil in a suitable position sets the lens rocking from side to side about the point of contact with the table. This motion soon develops a component motion at right angles to the former one and by super-imposition of these two, the luminous point, executes beautiful Lissajous' figures which are directly seen by the eye.

If a large number of trials are taken, the often repeated is the pattern for frequency ratio 1 : 1 and some-times that corresponding to frequency ratio 2 : 1 which is less frequent. More complicated patterns are also obtained.

V. L. TALEKAR

Department of Physics,
Dungar College,
Bikaner, 10-4-1947.

TAPIOCA AS A SOLUTION OF THE FOOD PROBLEM

I

MATHEW[1] has raised a very interesting topic in suggesting the cultivation of tapioca in Bengal as a solution of the food problem. He has stated that tapioca plants grown in Baranagar are thriving well and has given figures to show that the yield of tubers is also satisfactory. The variety of the plant has not however been mentioned. There are mainly two types of tapioca, (1) the bitter (*Manihot utilissima Pohl*) and (2) the sweet (*M. palmate Müll-Arg*) varieties. The tubers of the former, which are richer in starch (30 per cent), contain a glucoside, phaseolunatin, giving rise to hydrocyanic acid on hydrolysis, and are therefore unsuitable for human consumption. These are mainly used for the manufacture of starch. The sweet tapioca tubers, having a starch content of about 20 per cent, contain this glucoside only in the peels which can be easily removed, and these constitute an important item of food of the native population in the regions where the plant is indigenous (*e.g.*, coastal regions of S. India, Malaya, East Indies and tropical S. America).

The suggestion has been made that since the yield of tapioca tubers per acre is high compared to that of cereals, the cultivation of tapioca in some of the areas usually producing cereals would lead to an over-all incease in food production. But when comparison is made between the relative yields of tapioca and cereals (*e.g.*, rice), it should be done on the basis of starch contents rather than on actual weights.

If we assume the average yield of paddy per acre in Bengal to be 20 to 25 maunds, containing 65 per cent of starch, this would be equivalent in starch content to about 5,300 to 6,700 lbs. of sweet tapioca tubers. Rice also contains about 8 per cent of proteins and appreciable amounts of vitamin B_1, in both of which tapioca is deficient. Besides, the lands on which rice is grown generally bear another crop between the harvesting and the next sowing season, while tapioca needs at least one year to be ready for harvesting. From experiments conducted at Baranagar, the estimated yield per acre of tapioca has been given as 6,700 lbs. It would therefore appear that unless the yield of tapioca can be increased far above this figure, it would not be profitable to convert any paddy lands into tapioca plantations. Tapioca however is said to thrive in relatively dry weather and on soil free from water-logging. It would be worth while to try growing this plant in dry and waste lands on which no food crops can be grown due to inadequate rainfall or lack of irrigation. It might also be grown as a catch crop in orchards or other plantations which take some years to mature.

The isolation of starch from tapioca tubers is to a large extent carried out as a cottage industry near the site of the plantations, without the use of costly machinery, although the product is not as white as that produced in a modern factory. Tapioca starch, also known as Cassava starch, is also extensively used as food and is marketed in the forms of flakes, pearls and grains and also as powder for culinery purposes. In industry, tapioca starch is used for conversion into glucose, and it is specially preferred to other types of starches for the manufacture of adhesives. So great was its demand in the U. S. A. before the last war that 382,000,000 lbs. of it were imported into that country during 1939 as against 42,000,000 lbs. of all other starches combined.

If tapioca proves a success in Bengal soil, particularly in the hill tracts of Chittagong, Tipperah, Mymensingh and red soils of Bankura, Birbhum and the adjacent areas, it should open up new promises, not only in the production of food but in the development of industry as well.

In this connection it may be added that it would also be worthwhile to make a study of the economics of production of *Shoti* (*Curcuma zedoaria Roxb*), another starch-bearing plant of promise[2], indigenous to Bengal.

S. Mukherjee

Bengal Immunity Research Laboratory,
Calcutta, 26-5-1947.

[1] Mathew, N. T., Science and Culture, *12*, 557, 1947.
[2] Mukherjee, S. and Bhattacharya, S., *J. Ind. Chem. Soc*. Ind. News Ed., *8*, 4, 1945.

II

I am glad to find from the note by Mukherjee[1] that he fully appreciates the possible importance of tapioca in relation to the food problem and in relation to certain industrial and other uses. Since writing my previous note[2], I have received a number of letters from people in Bengal and Orissa interested in the cultivation of this crop. In particular I want to mention a detailed note[3] by R. N. Ray (19, Manir Hussain Lane, Narinda, Dacca) who has been cultivating tapioca in the Dacca and Chinsura Agricultural schools since 1927 with great success. Ray considers his results satisfactory in every way, except in getting other people to take an interest in the crop.

Regarding the points raised by Mukherjee on the question of the variety of the crop, I am unable to state the botanical name of the species or the variety on which my experiments were conducted. It is however not the bitter variety referred to by Mukherjee. People familiar with the cultivation of this crop in Travancore, have informed me that over 200 distinct varieties of tapioca are known. The plant is capable of both vegetative and sexual reproduction.

Regarding the comparison with paddy, I must mention that the yield of 20 to 25 maunds of paddy per acre, and as mentioned by Mukherjee is an overestimate of the average yield of paddy in Bengal. Surveys conducted by the Indian Statistical Institute for several years show that about 10 to 15 mds. would be a better estimate for the province as a whole. Also the yield of 6,700 lbs. of tapioca per acre obtained at Baranagore cannot be regarded as a fair sample, as most of the plants were damaged by rats. In Travancore yields of 10 to 15 tons per acre are quite common. For a fair trial of the possible yield in Bengal an experiment on a fairly large scale (say, 5 to 10 acres) would be necessary. Apart from this, as Mukherjee observes, the comparative merit of tapioca lies also in its ability to thrive on raised ground unsuitable for paddy and other cereals. Ray states the average yield to be 270 maunds per acre.

The variety with which we have been experimenting requires nearly 12 months between planting and harvesting. But there are other varieties which require only 9 months and some others which mature in 6 months. These latter varieties have also now been included in our experiments this season.

N. T. Mathew

Indian Statistical Institute,
87, Barrackpore Trunk Road,
Alambazar, Bengal,
12-7-1947.

[1] Mukherjee, S., Science and Culture, *13*, 1947.
[2] Mathew N. T., Science and Culture, *12*, 557, 1947.
[3] Ray, R. N., Unpublished note.

SUPPLEMENTARY EFFECT OF DIFFERENT VARIETIES OF SOYA-BEAN TO POOR RICE DIET

The Soya-bean Sub-Committee in their report[1] have concluded that in spite of the fact that soya-bean is superior to the other pulses in its net protein value, fat, minerals and vitamin content yet it has not proved itself a better supplement to a simplified rice diet than other pulses. They could not explain this apparent anomaly. The supplementing effect of five varieties of soya-bean to poor rice diet has been found to vary from 2.80 gms. to 5.68 gms. Such wide variations in the supplementing effect cannot be explained from the varietal difference in vitamin, minerals and protein. Ham *et al*[2] and De *et al*[3] have indicated that the nutritive value of soya-bean depends on the concentration of proteolytic inhibitor or any antigrowth factor that may be present in it. The present investigation was taken up to see to what extent the above factors affect the supplementary effect. For this purpose supplementary effect of different beans and glycinin, separated from them were studied.

The poor rice diet as it is known is highly deficient in various constituents and it was felt that if some of its deficiencies were made good the supplementary effect of soya-bean might be more apparent. Accordingly the basal diet was fortified with calcium, yeast extract and shark liver oil. Calcium lactate was added in the proportion of 0.7 gm. calcium to 700 gms. of the basal diet. To supply the B vitamins a slightly acid aqueous extract of yeast was given in amounts equivalent to 2 gms. of dried yeast daily per rat. Shark liver oil was included in the basal diet in quantities sufficient to supply 60 I.U. of vitamin A per rat per day. The composition of the basal diet was the same as used by Desikachar *et al*[4]. Six young rats 40 to 50 gms. in weight and including equal number of both sexes were used as experimental groups. One group was fed on the basal diet while the other group received diets in which 10 per cent soya-bean was added to the basal diet. The rats were fed on these diets for a period of 9 weeks. The results are as follows:

Diet	Average increase in weight per rat per week gm.
Basal	6.5
„ +10% Lyallpur (black)	6.2
„ +10% Ranchi (yellow)	9.2
„ +14% Ranchi (black)	7.2
„ +10% K_{16}	6.8

The results show that there is wide variation in the supplementary effect of different varieties and Lyallpur (black) has produced slight retardation in growth. Axtmayer[5] has shown that soya-bean protein has supplementary effect on rice protein and in spite of the fact that the basal diet contained 6.75 per cent protein mainly derived from rice, the Lyallpur (black) variety of soya-bean has not shown any supplementary relationship. It was postulated that the varietal difference in proteolytic inhibitor concentration or of the anti-growth factor may be responsible for this difference.

With a view to find out how far glycinin, freed from these factors, would supplement the basal diet, 4 per cent glycinin was added to the basal diet and the experiment repeated as before. The following results were obtained:

Diet	Average gain in weight per rat per week gm.
Basal	6.7
„ +4% glycinin from Lyallpur (black)	8.8
„ +4% glycinin from Ranchi (yellow)	8.9

The above results indicate that Lyallpur (black) variety of soya-bean contain more of the proteolytic inhibitor or anti-growth further affecting its supplementary value. Systematic investigation is in progress to determine the relative concentrations of these factors in different varieties of soya-bean and their effect on its nutritive value. My best thanks are due to Prof. V. Subrahmanyan for keen interest in the work.

S. S. De

Department of Biochemistry,
Indian Institute of Science,
Bangalore, 20-5-1947.

[1] Soya-bean Sub-Committee Report, Indian Research Fund Association, January, 1946.
[2] Ham, W. E., Sandstedt, R. M. and Mussehl, F. E., *J. Biol. Chem.* 161, 635, 1945.
[3] De, S. S. and Ganguly, J., *Nature*, 159, 341, 1947.
[4] Desikachar, H. S. R., De, S. S. and Subrahmanyan, V., *Annals of Bio-chem. and Expl. Med.*, 4, 61, 1936.
[5] Axtmayer, D. H., Puerto, Rico., *J. Pub. Health and Trop. Med.*, 21, 274, 1946.

SCIENTIFIC ATTACHES A NEW DIPLOMATIC POST

India is signifying her new international status by the appointment of Ambassadors to the most important countries. This letter is a plea for the creation of a new type of diplomatic post: that of scientific attaché.

India has ambitious plans for industrial, agricultural, and social development. In an age when development in any field is bound up with the technological state of the country, and when technology plays a large part in the fulfilment of any plan, it is

obvious that India can benefit by contact with other industrially more advanced countries.

The problems which faced Russia twenty years ago and which China faces to-day are similar to India's. A knowledge of their solution of these problems is of vital interest to India. America's vast technical knowledge and experience must be tapped if Indian industries are to develop along the most efficient lines. India must have men in these countries who can correlate this knowledge and experience; who can arrange for the interchange of scientific and technical knowledge between India and these countries. With science playing a leading role in the development of modern civilization, it is obvious that scientific attachés will be at least as important as military attachés.

May one hope that our leading scientists and scientific bodies will impress this fact upon the Government?

H. E. EDULJEE

120, Karnani Mansions,
Calcutta 16, 17-7-1947.

TITANIUM IN SOILS

I READ with considerable interest Sircar's article on "Nutritional Requirements of Plants".[1]

Recently I had occasion to observe that some grasses and other flowering plants flourished and grew very well in sand dumps devoid of any humus; the only plant food that was abundant in such dumps is iron derived from the ilmenite, a good percentage of which existed in the sand.

Titanium, though its chemistry is not so very well known, is more plentiful in the Earth's crust than Mn, Ni, Cu and Zn and is almost invariably present in soils derived from laterites. Very many years ago while carrying out chemical analysis of soils, I had occasion to observe that, sometimes clear HCl extract aliquots, on heating, turned turbid even before the addition of the reagent for the precipitation of the iron group. Having now studied the behaviour of Titanium solutions, I am inclined to suggest that the cloudiness might have been caused by Ti. I have no means of verifying this now. But Ti has a definite tendency to hydrolyze, when heated unless the ionization is suppressed by means of the addition of tartaric or oxalic acid. If therefore, Ti is not separately estimated, when present, it appears to me that its influence on plant growth is likely to become oblivious.

P. VISWANATHAN

Travancore Minerals Co., Ltd.,
Quilon, 25-7-1947.

[1] Sircar, S. M., SCIENCE AND CULTURE, *12*, 577, 1947.

A NOTE ON THE TEACHING OF CHEMISTRY IN INDIAN UNIVERSITIES

A COMMON feature in the teaching of chemistry in the undergraduate course in Indian Universities is that the bulk of the material treated relates to facts and theories of inorganic chemistry. Specialization in organic, physical or inorganic chemistry is taken up in the post-graduate course, where it has been a common experience that the students generally fight shy of taking inorganic chemistry as their special subject in view of its particular emphasis on the quantitative aspect of the study. The result is that most students go in for organic or physical chemistry, while the inorganic chemistry is systematically neglected. Dr H. R. Ambler of the Inspectorate of Military Explosives, Kirkee wrote in an article[1] about his "shocking" experiences in connection with the recruitment of war-time staff for chemical inspection duties. The following extract is typical

"On the whole, we did not find, that there was very much correlation between a man's degrees and the kind of knowledge which a scientific department wants. Although degree examinations may possibly be the least unsatisfactory general method of assessing a man's knowledge and abilities, they certainly do need a great deal of supplementing. Here are a few glaring examples. A man with a first class Honours degree who had done research on dipole moments, was obviously unaware that barium sulphate was insoluble in water. One with a good English degree and an American research degree proposed to determine the strength of permanganate solution by titration with sulphuric acid. Another with an Indian degree and an English Ph.D. unashamedly admitted that he had forgotten his second year course and was amused and rather resentful at being asked about such things as the determination of chlorides. Then there was a man who had worked for years on the polarimetric testing of sugars but had never heard of the term 'optical activity'. It is rather a shocking thing to say, but it has been the exception rather than the rule here to find graduates who have any ideas as to the method of determining sulphates, and the proportion who can describe the process with accurate experimental details is very small indeed. As an example of a complete mental blackout as to chemical methods, I may mention the case of an applicant who was asked how he would obtain ammonia from ammonium sulphate, and said, 'by treatment with hydrochloric acid'. Indeed the number who in reply to this question have suggested the use of any form of alkali has been small. A parallel example on the manipulative side was provided by an applicant who was given a burette and some solutions and told to do a titration. He washed the burette out with water, ran the water out until there was about 2 c.c. left, and then filled up with acid. One cannot but think that people who can say and do such things never had any working idea about either chemical theory or chemical practice."

It has been our common experience during the training of students for the Post-Graduate M.Sc. course that the students with B.Sc. Honours degree in Chemistry are often found to be quite innocent of the way how to set an analytical balance in order, to calibrate a weight box or a burette, or even to

properly use a pipette for delivery of solutions. Above all, they betray a sad lack of mechanical sense. Teaching of science without instilling the habit of precision, method, discipline, logical and clear thinking that avoids all preconceived notions and prejudices, defeats its own purpose.

Men for teaching undergraduate chemistry have had, therefore, to be selected out of a large number of such candidates as have looked upon inorganic chemistry as a subject of secondary or no interest during the period of their specialization. These men employed for teaching undergraduates can scarcely be expected to do justice to the major subject of the undergraduate course, viz., inorganic chemistry, and thus we find, not unnaturally, that a large number of students have already developed a distaste for this fundamental part of chemistry before graduation. A chronic lack of trained teachers in inorganic chemistry in undergraduate course leads to fewer students getting specially interested in the subject, and fewer students mean smaller production of trained teachers. Thus the vicious circle continues and the training in inorganic chemistry, which forms the foundation of all other branches of the subject, is utterly neglected. The result has been a general and progressive deterioration in the standard of training and the accomplishment of students almost in all the Indian Universities so far as chemistry is concerned.

Besides undergraduate teaching, where there has already been felt a dearth of trained inorganic chemists, it is to be noted that the many post-war schemes for development, now under consideration by the Central and Provincial Governments in India, in the fields of metallurgical and heavy chemical industries, in glass, ceramics, cement, refractories and other silicates technology, etc., are going to place a heavy demand on the Universities for personnel properly trained in inorganic, analytical, research and technological work in no distant future. Every effort should be made, here and now, to train up properly qualified men on an All-India basis in the shortest time possible, and I think that for this purpose the Inter-University Board would be the fittest body to take the necessary initiative. I hope that the matter might be brought up for discussion in the forthcoming meeting of the Board at Cuttack, and a resolution like the following, or one drafted on the same principle and along similar lines might be moved and adopted:

"In every University Laboratory, admission and seats should be so distributed as to ensure a proper proportion among students of pure chemistry specializing in the three different branches of the subject, viz., Inorganic, Organic and Physical, so that there may not be any dearth of trained chemists needed for efficient teaching and to develop different types of basic industries in the country."

P. RÂY

University College of Science
and Technology,
Calcutta, 11-7-1947.

[1] *J. Sci. Ind. Res.*, 2, 156, 1944.

PRELIMINARY EXAMINATION OF THE FRUITS OF *TERMINALIA BELERICA* ROXB

Terminalia belerica popularly known as 'Bahera' and a common commercial commodity in the Indian market forms one of the three important ingredients collectively known as 'Trifla' and is a household laxative in chronic constipation. Experiments were undertaken with a view to see the nature of the purgative principle. An aqueous portion (A) and a residue soluble in water obtained from an ethereal portion (B) were obtained by treating finely powdered dried fruits with rectified spirit. These two extracts were next tried on the carotid blood pressure of dogs anaesthetized with a mixture of urethane and barbitone introduced into the saphenous vein. Graded doses ranging from 0·5 c.c. to 5 c.c. of the two aqueous solutions were intravenously injected.

A fall in blood pressure was noticed with both the watery solutions (A) and (B)—though this was more marked with (B). After two doses of 0·5 c.c. and 1 c.c. of solution (A) the animal passed liquid stool. This purgation was, however, not seen when solution (B) was similarly injected.

It appears, therefore, that the purgative principle of 'Bahera' is a water-soluble substance which resides in the aqueous extract.

M. D. CHAKRAVARTI
J. N. TAYAL

Department of Pharmacology,
Medical College,
Agra, 8-8-1947.

SCIENCE AND CULTURE

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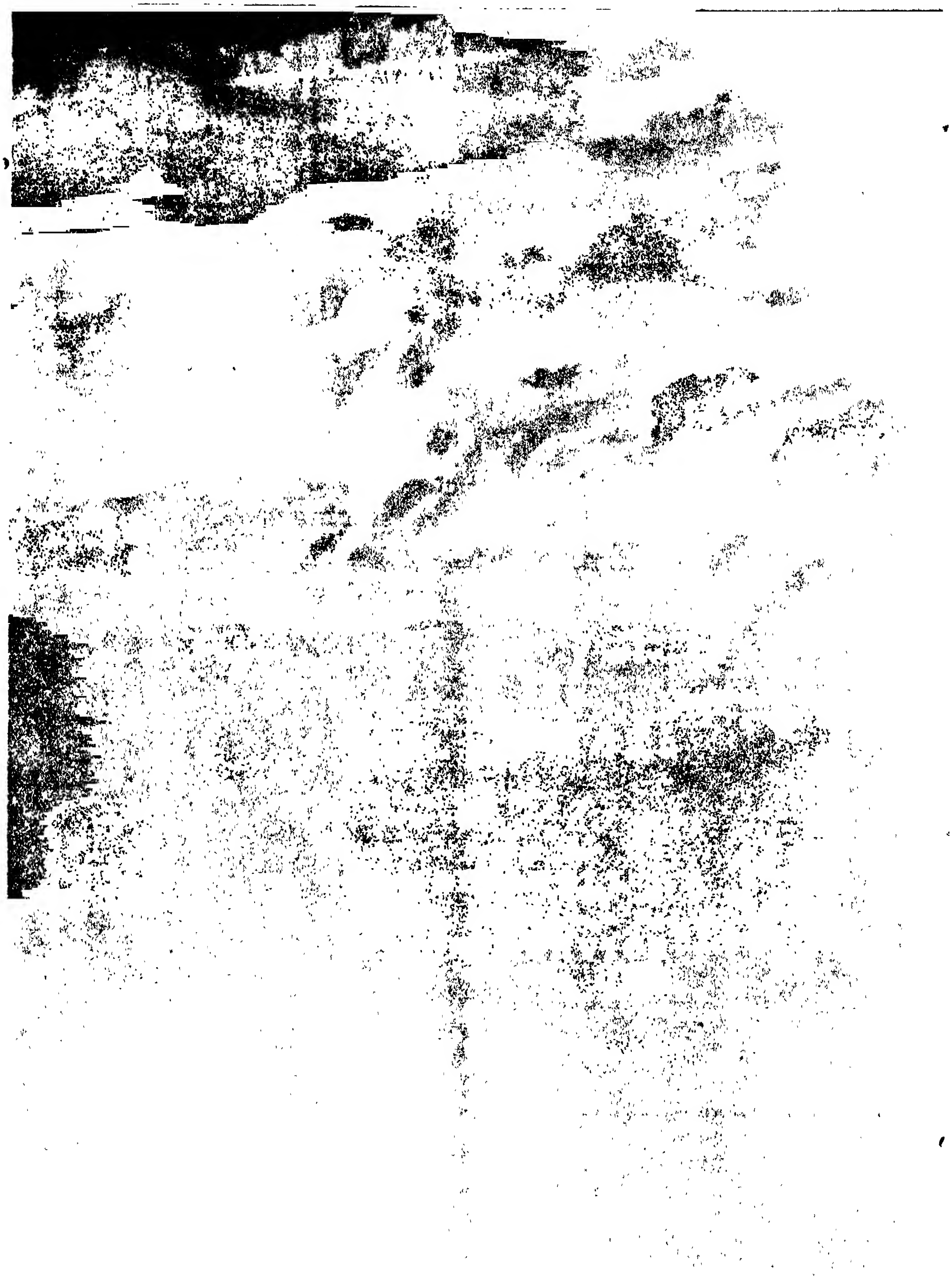

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SCIENCE AND CULTURE

A MONTHLY JOURNAL CONDUCTED UNDER THE GUIDANCE OF THE

INDIAN SCIENCE NEWS ASSOCIATION

TO DISSEMINATE THE KNOWLEDGE OF SCIENCES AND ADVOCATE THE APPLICATION OF THIS KNOWLEDGE TO A PROGRAMME OF NATIONAL WELFARE.

Vol. 13, No. 4] [OCTOBER, 1947

CONTENTS

SCIENCE AND CULTURE
A Monthly Journal of Natural and Cultural Sciences
Vol. 13 OCTOBER 1947 No. 4

NATIONAL RESEARCH COUNCIL

THE public will be happy at the recent announcement of the Government of India for the formation of a

(1) National Planning Commission for the Indian Union, and a

(2) Scientific Advisory Council.

We have suggested that (2) shall be called 'National Research Council', and be an integral part of the National Planning Commission.

These steps for national reconstruction were long overdue and the Nehru Cabinet within a week of their assumption of power has taken some concrete steps. We have given a good deal of thought to this question in the columns of this journal and as such we feel that we are in a position to make some practical suggestions. In doing so we have taken into consideration Prof. A. V. Hill's Report (*Vide* SCIENCE AND CULTURE, February, 1944), the Report on Scientific and Industrial Research (The Chetty Committee Report, *vide* SCIENCE AND CULTURE, 1945), the Report of the Indian Scientific Mission (not yet published) and the Resolutions of the National Institute of Sciences of India. Our suggestions are embodied in the schematic plan given overleaf.

Before we actually deal with the different aspects of our suggestion, it is considered desirable to mention a few words regarding the state of planning and other such activities in this country. About three years ago mainly as a result of Prof. A. V. Hill's recommendations, a department of Planning and Development was created by the Government of India and was put in charge of Sir Ardeshir Dalal. It had started its work through several panels which were busy in making integrated plans, but after a short career of two years, this nation-building department was suddenly abolished for reasons not disclosed to the public. During the short term of its existence, this department came in for a great deal of criticism which, we have reasons to think, were not connected with its working, but for functions which it attempted to assume. Somehow, the department was under the idea that its function was not confined only to planning, but extended also to include the execution of those plans (development). It was this idea which brought the department into direct conflict with other departments of the Government of India as each of them felt that their sphere of activity were to be very much curtailed and they were going to be bossed by a Superdepartment. Naturally these departments became very critical of the former, as they felt that what was their legitimate field was being usurped by this department. One of the contemplated functions of this department was to bring as recommended in the Hill Report all scientific research establishments under its own fold, but with the exception of the Council of Scientific and Industrial Research which was transferred to its care from the Department of Industries, it failed to bring any other into its sphere, as that move was very much contested by other departments. It is therefore extremely important to define in precise terms not only the functions of every new organization which is brought into existence, but also to define its *level*, and relations with other departments for omission to do so will simply create *confusion*, and tend to futility.

Though the Department of Planning and Development had too short an existence for giving any effective direction to Government policy, experience shows that if the country is to solve its problems, long term government policy and action should be separated from short term policy and from day to day administration. Framing of long term government policy should be in the hands of a continuously functioning National or State Planning Commission as described in our editorial of January 1947. The Chairman of the Planning Commission must be placed on a ministerial level, *i.e.* should be an im-

PEOPLE OF INDIA

NATIONAL ASSEMBLY

Prime Minister

Ministries

Planning (National Planning Commission)		Agriculture Food	Health	Industries Supplies	Education & Culture	Work Mines & Power	Communi-cations	Transport	Defence	Labour etc.
Councils for Labour Finance Commerce Defence etc.	N. R. C. — N. I. S. — Academies Scientific Societies etc.	A. R. C. Inst. Ag. R. (Delhi) Inst. Sugar Technology (Cawnpore) Sugar Breeding (Coimbatore) Dairy Res. Inst (Bangalore) Vet. Res. Inst (Muktesar & Izatnagar) Cotton Res. Inst (Bombay) Jute Res. Inst. (Calcutta) Lac. Res. Inst (Ranchi) Rice Res. Inst (Cuttack) Tobacco, Coconut etc.	M. R. C All Ind. Inst Hygiene (Calcutta) Nutrition Res. Inst (Coonoor) C. R. I (Kasauli) Haffkine Ins (Bombay) etc.	C. S. I. R. National Labs Physical Chemical Metallurgical Glass & Ceramics Fuel Roads Atomic Energy Board etc	U. G. C A. I. C. T. E. Ind. Inst Science (Bangalore) Proposed Technical Ed. Institutes etc	T. P. B. C. I. N. W. C River Res. Labs Poona Lahore Calcutta	A. I. R P. O Telephones	H. P. Ry. Com I. R. C	M. G. O Aircraft Res & Design Ordnance Labs. Cawnpore Kirkee Gun & Shell Fact Cossipore etc.	

N. R. C .. National Research Council

N. I. S. .. National Institute of Science, which a private body of senior scientists and has been recognised by the G. I. as the representative body of scientists.

A. R. C. .. The Agricultural Research Council (now called Indian Agricultural Research Council).

M. R. C. .. Medical Research Council (this function is discharged by the Indian Research Fund Association, which should be renamed as M. R. C.).

C. S. I. R. .. Council of Scientific and Industrial Research.

U. G. C. .. Universities Grants Council (now Universities Grants Committee. This Committee has hardly functioned)

A. I. C. T. E. .. All-India Council of Technical Education (now sitting under the Chairmanship of Mr N. R. Sarkar)

T. P. B. .. Technical Power Board.

C. I. N. W. C. .. Central Inland Navigation and Waterways Committee

A. I. R. .. All India Radio.

P. O. .. Post Office.

H. P. Ry. .. High Power Railway Committee.

I. R. C. .. Indian Roads Congress.

M. G. O. .. Master General of Ordnance.

The Scientific Surveys have not been shown in the above scheme. Their names, and Ministries to which they are affiliated are shown below :

Geological Survey of India	(Work, Mines and Power)	Anthropological	(Education)
Meteorological	(Communications)	Archaeological	(Education)
Botanical	(Agriculture)	Trigonometric	(Defence)
Zoological	(„)		

portant member of the cabinet. The Planning Commission should have sections or councils as we have called them dealing with all the activities of a modern State, *e.g.*, industry, commerce, agriculture, finance, defence etc. . . ., but the activities of these councils would be confined only to planning as defined here, not to execution or day to day routine.

For effective planning on a nationwide scale, a good deal of scientific research and survey are to be carried out in different scientific establishments belonging to different ministries of the Government of India. The present establishments and their affiliation to the different ministries are shown in the chart. Some of these scientific establishments are of long standing, others are recent, and many new ones are under contemplation. While in most cases it may not be necessary to interfere with the functions of these scientific establishments, and their affiliation to the existing Ministries, it is desirable that their activities should be known fully to the National Planning Commission, their works are co-ordinated, and the progress of the plans entrusted to their care are supervised by the same body. In the present make-up of the Government of India, there is no organisation to look after these functions. We suggest that these functions should be assigned to the National Planning Commission which as far as scientific establishments are concerned should discharge this task through one of its Councils,—to be called the *National Research Council* or *National Council of Science*. This should be composed of

(1) A Chairman and a Vice-chairman with a proper secretariat. Both should be distinguished scientists and the Chairman should be a full member of the National Planning Commission.

(2) The scientific executive heads of the various scientific establishments and of the more important surveys shown in the chart will be ex-officio members of the N. R. C. Provision should be kept for alternate members from each establishment, who should take the position in the N. R. C. when the head of the establishment is not available.

(3) A few members, having scientific and technical qualification may be nominated by the Prime Minister, the N. P. Commission, or the Cabinet.

As shown in the schematic chart, although the departmental members who are respective heads of their establishments will remain under the administrative control of the Ministry concerned, the Chairman of the National Research Council will have full authority to ask for records and reports either on the preparation of plans or on their execution. This will fix responsibility and will also avoid unnecessary administrative difficulties and redtapism.

Method of Work

The task of the preparation of the individual plans will remain with the relevant scientific establishments, but the National Research Council will have to scrutinise and make these plans into one integrated whole. This will avoid duplication and will also keep the N. P. Commission informed of the scientific work going in all departments. Once the plans are accepted the execution of the plans will be the legitimate function of the relevant establishment under the powers relegated to it by the Ministry concerned. But the National Research Council should be invested with the authority of finding out whether the plans that have been approved are being properly executed and in this respect it will exercise a supervision on the fulfilment of the plans by way of seasonal reviewing of the progress of the plans and make modifications and suggest to the department means for their speedier execution.

Such an organization which should have access to the relevant records, and documents of all the departments will also be helpful in ensuring the co-operation of all the departments in the execution of plans which is of fundamental importance in integrated development. The Chairman of the National Research Council through the National Planning Commission will thus be vertically linked up to the Cabinet and keep it fully informed about the progress of the plans. Vertically down he will be linked up with the work going on in all the scientific establishments of the country. Horizontally he will be linked up to the other co-lateral Councils of the N. P. Commission on finance, commerce, labour, defence etc.

With regard to the distribution of the sectional establishments which cover interdepartmental boundaries the National Research Council may make recommendation to the Cabinet for decisions. As an instance, the question whether Road Research should be under the control of the Ministry of Transport or under the Council of Scientific and Industrial Research should be decided by the National Research Council and its recommendation will be passed on to the Cabinet for final promulgation of administrative order. The National Research Council by itself will not have the authority to shift one establishment from one department to another.

It may be argued that the composition of the National Research Council has excluded industrialists, public men, etc. The experience of the last few years of having non-scientific members on important scientific councils has led to such a proposal; because it is felt that in matters of scientific research it is too much to expect that the industrialists will

take much intelligent interest. However, a system of liaison which will keep the National Research Council fully informed of the requirements of the Industry, Defence, etc., can be maintained through the different Councils of the N. P. Commission, and its Statistical Department.

SUMMARY

According to our scheme, the National Research Council will be composed of

(1) A whole time Chairman and Vice Chairman who should be distinguished scientists. The Chairman should be a member of the National Planning Commission representing 'Scientific Research' on that body. The Vice-chairman will be the alternate member. The duty of the Chairman and his staff would be to study continuously the research activities of all the scientific establishments and organisations, scrutinise their plans, and effect coordination by means of periodic conferences and consultations. The conclusions should be submitted to the Cabinet through the National Planning Commission.

(2) The executive heads of the Agricultural Research Council (A. R. C.), the Medical Research Council (M. R. C.), Council of Scientific and Industrial Research (C. S. I. R.), Chairman of the Universities Grants Council (U. G. C.), Chairman of the Technical Power Board (T. P. B.), Chairman of the Central Irrigation, Navigation and Waterways Committee, Chief Scientific officers of All India Radio, of Posts, Telegraphs, Telephones, Chief Scientific Officer of the Defence Ministry (Master General of Ordnance). In every case provision should be kept for alternate members representing the departments.

(3) Three or four representatives of the National Institute of Sciences representing fundamental research, heads of important scientific surveys like Meteorology, Geology, and Trigonometric survey. It is necessary that they should be all scientists. An alternate member should be nominated from each constituent body who would automatically take the place of the regular member, when the latter is not available for discussion or consultation.

(4) A number of members nominated by the Premier, or the National Planning Commission from amongst the distinguished scientists of the country.

Addendum:

Proposed New Institutes of Research

In the above chart of the scientific organization it has not been possible to collect information on any scientific units in the Posts and Telegraphs Department (there are workshops, which during the war, supplied useful accessories in Alipore, Calcutta and in Jubbulpore) and in Transport Department (work of standardization units in the Railways is yet to be organized on a scientific basis). We would welcome information on the work done and the scope and possibilities in these two services. About the Defence service, the veil of secrecy hangs very heavily, but we suppose the Department (now the Ministry) does not possess a sufficient scientific personnel for carrying on original works. The following note gives a sketch of the nucleus of scientific organisations for defence. Besides the national laboratories already established or under contemplation as noted in the chart, the Indian Scientific Mission that visited the United Kingdom, the United States of America and Canada during the winter of 1944-45, has recommended the establishment of the following laboratories on a national scale:

1. Institute of Food Technology,
2. Oils and Paints Institute,
3. Industrial Fermentation Institute,
4. Electro-chemical Institute,
5. Central Geophysical Institute,
6. Power Technology Institute (one has been established at the Institute of Science, Bangalore),
7. Meteorological Research Institute,
8. Institute for the Design of Industrial Plants and Fabrication of Pilot Plants,
9. National Institute for Medical Research,
10. Industrial Hygiene Research Institute.

No plans for any of these Institutes have yet been evolved.

Nucleus of Scientific Organization for Defence

The M.G.O. (Master General of Ordnance) has a number of production factories and testing laboratories under his control. The production factories are:

1. Gun and Shell Factory, Cossipore (Calcutta),
2. Rifle Factory, Ishapore (Calcutta),
3. The Mathematical Instrument Office (Calcutta). (This was originally under the Survey of India, then during the war under the Defence Department, and as there was an unwise step in retrenchment in this trained and skilled unit, suggestion has now been made to transfer it to the C. S. I. R.),
4. Gun Carriage Factory (Jubbulpore),
5. Inspectorate of Explosives (Kirkee, Poona),
6. Cordite Factory (Aravankadu, Nilgiris),
7. Inspectorate of Stores and Clothing—Ordnance Research Laboratory (Cawnpore).
8. Saddling and Harness Factory (Shahjahanpur).

The Cawnpore Laboratory only has been engaged in wide range of testing, and was established during the war.

There appear to be no production factories for naval or air arms (a small unit of about 150 men trained in air-craft testing instruments has been disbanded from M.I.O. and reports say that they have been absorbed by a commercial air service organization). The Hindusthan Aircraft Factory at Bangalore set up during the War as an assembly and repair shop for aircrafts has its present status undefined and its future is uncertain.

To our knowledge, India had never any permanent research laboratory for any of the three arms of defence, Army, Navy or Air, as in the U. K., or other foreign countries. In England research laboratories have formed from old times permanent establishments of the Admiralty, the Army, and the Air Ministry. During World War II, the labours of a huge army of physicists, chemists, technicians and biologists were mobilized for assisting in the devising of new weapons of offence and defence. The following note is quoted from the Report of the Indian Scientific Mission (1944-45) submitted to the Government of India. It reveals the nature of scientific organization that Defence services developed.

"One of the research laboratories under Radio Board under the aegis of Ministry of Aircraft Production)- the Telecommunication Research Establishment under Dr A. P. Rowe was visited by two of the members of the Indian Scientific Mission (1944-45). Fundamental investigations on radar at a very high level were being conducted there. A sort of radar university had grown up here under the leadership of Dr J. A. Ratcliffe (Cambridge) and Dr L. Huxley (Nottingham) for imparting radar training. 'Synthetic Radar Trainers' had been devised which had saved the R. A. F. 50 million sterling worth of aviation spirit. It was here also that the visitors were first introduced to some of the mysteries of the radar, such as P.P.I., I.F.F., etc. Mention should also be made in this connection of the visit to the Radar Research and Development Establishment in charge of Dr Gough under the Ministry of Supply. This organization is concerned mainly with development of radar equipments. At a later date the Mission, through the courtesy of General Sir Frederick Pile, had the opportunity of visiting one of the Coastal Defence Stations where radars were being employed to locate and bring under fire V-1 bombs.

"It was interesting to note that the research workers, particularly those engaged in developing new devices and techniques were mostly academic men with experience in fundamental research. As an instance in point, mention may be made of the development, by a band of research workers in the University of Birmingham, of the special type of magnetron for generation of centimetre waves of high power. The use of centimetre waves has made possible many of the revolutionary developments in the radar technique."*

The Telecommunication Research Establishment (T. R. E.) at Malvern, where most of the original research on Radar (Radio detection of hostile aircraft) was done, employed at one time nearly 700 physicists and engineers besides other skilled and unskilled workers.

* The story of the development of radar and the British contribution to it appeared in the statement of Sir Stafford Cripps at a conference held at the Ministry of Information on August 14, 1945.

AERIAL PROSPECTING OF MINERAL RESOURCES

OF all the techniques that are proposed for the future activities of the world, aviation is bound to play a very important part. No doubt some of the possibilities of aviation, such as for transport, postal service, rapid liaison, etc., are already well known, yet there are many others which, in the near future, must be explored in all their aspects. For instance, aviation will be of immense help in working out topographical plans and geological maps and also in the exploitation of mineral wealth that may be situated far away from the metropolis, lost in deserts, in mountainous regions or in deep forests. Aviation will help to discover them, to connect them with the civilized world and to transport the materials dug out. It is no longer a matter of wild fancy ; the foundations for such work have already been laid and some striking achievements have already shown the advantages of the applications of aviation.

In the year 1936, in the Hawaii island, the volcano Maura Loa burst forth into eruption. The hot liquid lava flew through some narrow tunnels of hardened lava which prevented the flow from cooling down. Some bombs properly dropped from the air smashed the vaults of these tunnels. A general cooling followed and arrested further flow of the lava.

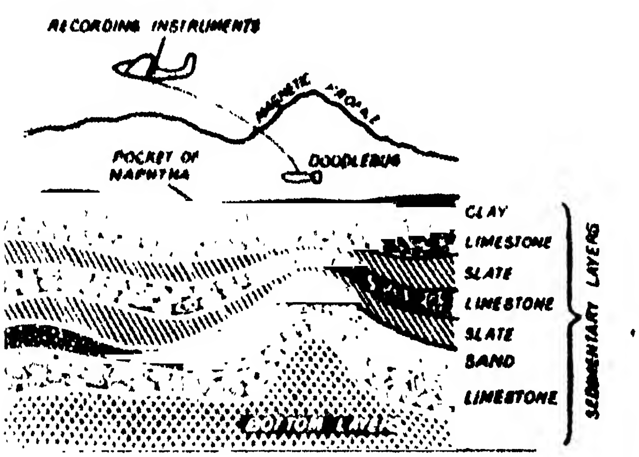
This is one of the numerous examples of the use of bombardment from the air for peaceful ends. The bombing of storm clouds for fighting against hailstorm or the utilization of aeroplanes or helicopters for large scale treatment of forests or of orchards against insect pests may also be recalled in this connection.

Some time ago, aviation lent considerable help to the exploitation of gold mines of the province of Cotabambas (Apurimac) at Peru. These mines are situated in mountainous regions, 150 km. south-west

of Cuzco, in a site almost inaccessible at an altitude of 3,800 m. The nearest railway line passes at a distance of 110 km. from the mines and is separated by a mountain which could only be crossed by convoys of porters accompanied by lamas and mules. These took at least fourteen hours to complete the journey and carried a maximum load of 150 kg. They were replaced by two aeroplanes capable of carrying a load of two tons and crossing the mountain within an hour. Thus aviation provides the ideal means of transport and liaison between the centres of civilization and the regions of mineral exploitation hidden in mountanous or desert tracts almost inaccessible by terrestrial routes.

Aviation at the Service of the Geographer, Geologist and the Archaeologist

Aviation is remarkably helpful in tracing geographical or geological maps and in prospecting mines. The plan of any region can be obtained with the help of vertical photography from the air; while the differences of relief are brought out by wide range



Detection of Petrol with the help of the "Doodlebug"

[The curve marked "magnetic profile" depicts the variation of the terrestrial magnetic field. It gives a fairly accurate picture of the profiles of the subterranean layers. The pronounced elevation of the curve indicates corresponding swelling of the low layers of the earth which is quite likely to be caused by a pocket of naphtha.]

stereophotography and can be measured by stereophotogrammetry. Further, trained and competent observers can derive much useful information regarding the nature of the ground below simply by an examination of the forms and colours directly from an aeroplane. This is not all. It has been established recently that some known relations exist between the nature of certain types of terrain and the nature and intensity of the vegetation that covers them. The differences of colour obtained on special types of plates enable one to draw very important conclusions in this field.

No doubt, the service thus rendered by an aeroplane cannot entirely take the place of field work of topographers as well as of geologists. But it simplifies the work by helping them to determine the first outlines of the whole problem; and in particular it enables them to discover things which cannot be suspected from the ground. It is in this way that it has been possible to discover the ruins of an ancient city hidden under the sands of a desert which could not be detected by direct observation. In 1925, R. P. Poidebard had already discovered in this way some vestiges of Roman construction in Syria.

In Madagascar, aviation has been utilized either for completing the plans of ground surveys or for surveying regions of which topographical maps hardly existed or, last of all, for, what is of special interest to us, the exploration of inaccessible regions. Some remarkable results have in this way been obtained by the examination of vegetation or by direct observation of rocks. For instance, photographs made during the aerial survey of the mountainous mass of Ankaratra revealed the details of the lacustral basins ranged therein.

Even in France, aerial photography had already been used for constructing geological maps specially of mountainous countries, and for sketching excavations and terrestrial irregularities. In practice, this is generally done on a scale of 1 in 20,000 while for large structures, such as barrages, a scale of 1 in 2,000 or 1 in 5,000 is used. In other countries, however, aerial photography has been employed more extensively. The example of Canada is particularly instructive, drawings made here at an altitude of 1,000 metres and at a speed of 200 km. per hour enabled geological maps to be made at a cost of only 50 francs per square kilometer. In the year 1933, the geological exploration of Middleton island in the Gulf of Alaska was also made possible with the help of aviation.

It may be noted in this connection, that Mr Marcel Griaule, the explorer of the dark continent, extensively employed aeroplanes for his ethnographical researches with great profit. In the last National Congress of Aviation in which he presided over the section on "Applications of Aviation in Scientific Researches", he was able to co-ordinate the plans of geographers, archaeologists and ethnographists, all full of hope in these new methods. At a recent exhibition held on the occasion of the 9th Congress of Photography, attention was drawn to this technique by the display of stereoscopic panoramas and of special colour films made for disclosing camouflages.

Aviation—the Prospector of Mines

In order to carry on in a rational way the search for minerals hidden under the earth it is necessary first of all to prepare geographical and geological plans of the regions that are to be prospected. We have seen how aviation helps in this sphere. The first experiments have confirmed that for the exploration of minerals, aerial study, besides its rapidity, is substantially economical in view of its various other advantages such as suitability for prospecting vast stretches of land inaccessible by other means, elimination of certain topographical and geological surface effects, possibility of the application of other special techniques such as infra-red photography or gravimetric, magnetic and sometimes even electrical methods of prospecting.

The discovery of beds of pitch blend at Echo Bay in North Western Canada nearly in the arctic region was made with the help of aviation. Not only that, aviation also facilitated the exploitation of the source by providing an easy means of transport of the minerals collected on the spot at a distance of 13,000 km. from the nearest railway and separated by regions accessible only with great difficulty via terrestrial routes. This discovery made Canada the largest producer of radium, a place so long contended by the U. S. A., Belgian Congo, Bohemia, and Australia.

Besides radium, the place contains enormous deposits of Uranium, which were utilized for the manufacture of the atom bomb, and for the researches leading to it.

It is with the help of aviation again that researches on precious minerals have been extended to the North of Canada (coasts of Hudson Bay, regions of Flin-Flon and Sherritt Gordon at Manitoba). We may also recall in this connection the researches carried out in South Africa since 1935 by the Aircraft Operating Co., of Africa and the Applied Geophysics Ltd., of London, that led to the discovery of new mineral zones, thanks to the gravimetric, magnetometric, seismic and electrical methods of investigation. The study of the gold fields of Barberton, the most ancient known place of this region, has proved that the tectonic is generally evident on the aerial photographs and that prospecting by this method is very promising. No doubt, it is in the exploration of precious metals only that aviation has been utilized up till now. There are other elements, however, which will become as precious as gold in the near future and will require the same methods of research and rapid transportation; such are elements of special importance present in minute traces in the abundant metals (*e.g.*, vanadium, niobium), rare metals like caesium, gallium and precious stones, etc.

The "Doodlebug"—Detector of Submarines, Iron and Petrol

Among the different techniques suitable for application in aerial prospecting, we have mentioned the magnetic method. The latest apparatus used for prospecting by this method is the airborne magnetometer known in England and in America by M.A.D. (Magnetic Airborne Detector) or Doodlebug. Developed before the war for prospecting minerals this apparatus has been employed by the joint efforts of the Naval Ordnance Laboratory of the U.S.A. and the Bell Telephone Laboratories for the detection of submerged enemies. It gave good account of itself as it helped in destroying at least three submarines in the straits of Gibralter and perhaps many others. It was employed in conjunction with the Retrobomb, another weapon utilized by the Allies for fighting from the air against submarines. As regards the object for which it was first developed, *viz.*, search for petrol and other minerals, more than 100,000 sq. km. of land in the U. S. A. and in Alaska has already been surveyed with this device.

Tugged at a distance from the aeroplane in order to eliminate the effects of magnetic materials and electric currents inside the plane, this apparatus consists mainly of some stabilizing mechanisms which enable it to keep in a fixed direction, independent of the movements of the plane and the surrounding air, and carries an instrument sensitive to minute variations of the intensity of the magnetic field. The indication of this instrument is transmitted to a recording apparatus installed on board the plane. It is interesting to note here that the M.A.D. is thousand times more sensitive than the prewar magnetometers.

It is well known that if iron ores are present inside the earth's surface, large perturbations occur in the distribution of the lines of force of the terrestrial magnetic field; non-magnetic materials, such as petrol, on the other hand, cannot produce such perturbations by themselves. It happens, however, that a pocket of naphtha is often associated with a swelling of the lower layers of the earth which are more ferromagnetic than the surface layers. This results in a modification of the terrestrial magnetic lines of force. Thus the maxima occurring in the curves recording the intensity of the terrestrial magnetic field usually correspond to the presence under the earth either of iron ores or 'vaults' containing a store of naphtha.

Of course, there are many difficulties which shall have to be solved before prospecting from the air can be used as a perfect method. But from the examples given above it is evident that efforts in this direction should be encouraged. The creation of the "Bureau Aeronautique de la Recherche Scientifique" is a hopeful mark of new evolution in this line.

THE SCIENTIFIC ASPECTS OF VILLAGE UPLIFT*

R. B. LAL,
ALL-INDIA INSTITUTE OF HYGIENE & PUBLIC HEALTH, CALCUTTA

POLITICAL freedom is, by itself, a great boon, but our dreams would come true only when it heralds social emancipation of the teeming millions. Its advent should mean enjoyment of better health, greater prosperity, cultural advancement and happiness for the common men. Political freedom cannot stand alone, either freedom from wants follows soon or we lose our newly gained independence as well. We must work for it, we must plan for it. There has been some planning but most of it relates to big all-India schemes. There is surely a field for planning at the all-India level but it should be restricted to such schemes as are of common interest to the country as a whole or which can be worked efficiently on all-India basis only. They should constitute the *end-point* and *not the beginning* of the National Plan which must be an organic growth with its roots in the ultimate peripheral units the villages.

Much has been done to uplift village communities by our leaders but there is one aspect of it which needs emphasis namely the scientific aspect.

Whether we like it or not, we cannot ignore the current of historical events which constantly creates new situations from which we can not isolate ourselves except at the risk of stagnation in side-pool, where we must rot and decay. The torch of modern knowledge must enlighten the innermost recesses of of our vast country, if real progress is to be made in a short time.

So far the scientific talent of the country has mainly interested itself in dealing with big industrial schemes, exploitation of power and important mineral resources and cultural development at high level. The rural problem is a challenge to science. We must take up the challenge with the bed-rock of belief that by isolating problems and subjecting them to scientific research we can and must solve them.

The rural problem is equally a challenge to the Government. While functions of a modern State are no longer confined to the maintenance of internal peace and defence against external aggression, the old structure remains. We earnestly hope that the machine of Government will undergo radical change. Administrators have so far dominated over scientific and technical men, while only the latter can deliver goods. What is the result? The goods are not delivered. People have accused the Government for all acts of commission and omission. The administrator has blamed the people for non-cooperation. His argument has been that people being conservative, illiterate, ignorant, apathetic and poor he has no other way but to force the reforms on them, in the hope, that in time they will recognise the good done to them and the reforms will become acceptable Whatever else it might imply it means this that a paid army of workers must be maintained to do the work and to supervise it, which can and should be done by people as ordinary routine.

The people and the Government have been like partners in a failing concern, one blaming the other for the loss. The old order must change and give place to new. It calls for audacious thinking Nothing short of a social revolution is indicated. The scientist must come to his own, he must be invited to assume responsibilities.

It is not our purpose to present a National Plan for village uplift, for, we believe, no such plan can be formulated at the present time. It must be evolved centripetally, intergrating, as it develops, the local plans best suited to the constituent units. We should, therefore, confine ourselves to the discussion of the essential *ingredients* of national planning.

As scientists we must know where exactly do we stand to-day? What are our assets and what are our liabilities? What causal factors are operating and with what force? This involves a systematic study of man, society and environment. Then in turn come planning, organisation, execution and finally assessment and review. Facts first, inferences afterwards, action last This is the way of science. Why should we not apply the scientific method to village uplift with the same reasonable prospects of success as in other fields? Nobody suggests, that things should wait till the surveys are completed. We should, by all means, carry on as best as we can but we are concerned here with planning. In this connection we may quote a sentence from Sir George Schuster's "India and Democracy". He says, "A plan cannot be made *a priori*; the experimental method is needed, and the organisation of social service calls for research no less thorough or critical than is found in a scientific laboratory". He urges the Indian statesmen to seriously study the Report of Lord Haldane's Committee on the Machinery of Government. It says "turning next to the formulation of policy, we have come to the conclusion, after surveying what came

* Presented to the Symposium on National Planning held at Delhi under the auspices of the Indian Science Congress Association, 34th Session, Delhi, January, 1947.

before us, that in the sphere of civil government the duty of investigation and thought, as preliminary to action, might with great advantage be more definitely recognised. It appears to us that adequate provision has not been made in the past for the organised acquisition of facts and informations, and for the systematic application of thought, as preliminary to the settlement of policy and its subsequent administration". Again, "we have come to the conclusion that the business of the executive government generally has been seriously embarrassed from the incomplete application to it of similar methods. . . ." The Committee urges strongly "that in all Departments better provision should be made for enquiry, research, and reflection before policy is defined and put into operation."

Those of us who have worked in rural areas know fully well that conditions vary greatly from place to place. They vary as regards the man, the society and the environment and consequently as regards the problems. No general plan will suit all parts of a large territory equally well, besides there will be time variations. This leads us to the inescapable conclusion that surveys of representative areas must be carried out from time to time. To be useful, efficient and economical, these surveys must be integrated, that is to say, the study must include all aspects of man, society and environment. We need two types of surveys, namely, (1) Detailed sample surveys of representative units of different sizes, (2) Brief surveys which would be complete induction of each small compact community unit such as a village. Both types of surveys must be designed and interpreted by teams of experts representing all fields of activities. The former will present an integrated picture of fair sized communities, bring out casual factors, and their relative significance, crystallize problems, indicate priorities and point the way towards remedial measures. They should also serve as base-lines from which progress may be measured. A special service must be organised to conduct these surveys and analyse the data. The second type of surveys should be organised by polytechnical village agents, about whom we shall say a few words later, and conducted by local volunteers. These surveys should provide deeper appreciation of the circumstances of individuals and families, of the liabilities and assets of the village as a whole and of its problems. These surveys should be repeated at suitable intervals. This then is the first ingredient of social planning.

The second ingredient in the evolution of national planning is to get across to the people the essential results of the surveys. It is wrong to suppose that the average villager is incapable of understanding what these results signify. The subject matter is of the greatest interest to him. If only the presentation is suitable to his way of looking at things he will grasp them as well as anybody else particularly the results derived from the second type of survey in which he has actively participated and which have a greater ring of intimacy. In any case this step is as essential as any for the successful development and execution of a progressive national plan. To ignore the would-be benefeciary is to play the Hamlet without the Prince.

We have pleaded for integrated surveys. The same principles should be followed not only in the evolution of the national plan but also in its execution. Much stress has been laid recently on inter-departmental co-ordination, but co-ordination is not enough, it is perhaps not always possible, what we want is integration—a combined effort. Looked at from the common man's point of view, he is interested not in *hyper* or *hypo* activity of this or that department, he is only concerned with the amelioration of his condition. At present he is bewildered by, if not suspicious of, the one sided propaganda which departmental agents impose upon him. He often finds it wholly unrelated to the realities of his situation. Like anybody else he wants first things first. He would very much appreciate an agency which will help him to get over his difficulties rather than a service which would worry him with things that can wait but which are being pressed simply because a particular departmental head happens to be extra active. It is, therefore, necessary that the village folk should have the services of a *poly-technical agent* who lives amongst them and who has no departmental bias but is motivated by the needs of the people he serves. It would be his business to stimulate and canalize their desire for better health, more wealth, finer culture and social emancipation, to organise them into an effective business corporation, to serve as their general business manager, to properly understand the local problems and to interpret the same to and secure the help of technical personnel for their solution. As a matter of fact there should be two poly-technical friends in a village, a man and a woman who would work in their respective spheres. They should be backed by a polytechnical board of experts and a set of institutions located at the smallest peripheral unit, in which all the fields of activities are represented according to local needs. While these experts would man their respective institutions, there should be no departmental rivalries because they must own joint responsibility. Their primary loyalty must be towards the satisfaction of the local needs and not to the individual departments. They should work as a team in the solution of the problem of the unit as a whole and of the constituent villages. Polytechnical boards and institutions with similar functions should be provided for bigger territorial units—such as a subdivision, a district, etc. and finally for the national unit. As the size of the terri-

torial unit increases so also will, the complexity of the problems and correspondingly the scope of the polytechnical boards and of the institutions. The experts of the polytechnical boards at higher levels will assist and supervise the work of their functional counterparts in the smaller units without interfering with the unity of purpose and collaboration between the colleagues of the subsdiary polytechnical boards.

Such a machinery will prove not only cheaper and more efficient but also more acceptable to the communities whom it is designed to serve. It will do away with the wasteful efforts which the various departments working in water tight compartments, make at present. Specialists will be able to make more fruitful contacts with the rural population giving better and more effective service and acquiring a more realistic knowledge in their respective fields. We call this, the third ingredient of national planning.

We have said that people and the Government have hitherto been like two partners in a failing concern, each trying to shift the blame on the other. With whom should the responsibility ultimately rest?

With all the people who inhabit the country, it is for all of us to contribute towards the individual and common good according to our utmost capacities and in the specific fields of activities in which we can profitably do so. The people and the Government should coalesce into one party, Government being merely the organ for the self-expression and planned endeavour of the community. How may this come about. This leads us to the fourth ingredient of planning.

We can put our hearts and our best effort into the struggle only when we are given an opportunity to think and to have our say in matters that concern us, with a fair chance of being heard. We, therefore, should have decentralisation and an intelligent and disciplined democracy, not a blind democracy. Let us explain. We have said that everybody must have a say, but can all of us have equal say in all matters, as universal vote implies? That is not so. This is where we go fundamentally wrong for it is plain as day light that most of us are not qualified to hold opinions on most matters and anyway we have no chance of being heard. In blind democracy it is an irresponsible franchise. Constituencies are big and individual vote is merely a drop in the ocean. We exercise our franchise and yet vast majority of us have no opinion of our own. Under the circumstances our votes carry little value in our own minds. No wonder then that external influences sway our votes. Either we don't care to exercise them or we do so according to inducement, pressure or vogue. While theoretically the successful candidate derives his sanction and authority from our votes, we have little power to influence his actual behaviour in respect of matters that concern us. What is the remedy? Under intelligent and disciplined democracy, provision would be made for intelligent appreciation of problems by the people as demonstrated by objective studies. Again the consultation would be realistic and effective, which only maximum decentralisation can achieve.

With decentralisation the sense of neighbourliness developes and with it the assurance that one is not crying in the wilderness. Thus one begins to own responsibility and participate in common activities with a sense of realism, sharing with others success and failure, loss and gain, pleasure and pain. Thus much of the potential force, now pent up in common man, would be released and applied to good purpose.

While each man should have the fullest opportunities for self expression, his activities should be conducive to the common good of the family and of the community. Likewise, each village while enjoying maximum freedom, choosing its own priorities and leading its own life should fit in, in a larger unit, that is to say with a group of villages such as a Union in Bengal. This as a unit will have a new set of common problems, common assets and common liabilities which again should be ascertained through in integrated survey in as much as they arise from and because of the combination of villages. To determine priorities and to own responsibility, the constituent village councils should elect a union council of representatives having regard to their superior knowledge and experience which would be required for dealing with more complex problems at union level. However, their task would be rendered easier and success assured because of the knowledge of facts and causal factors derived from the union survey and because they would have the benefit of services and advise of the union polytechnical board and the support of similar institutions of bigger units of which they form part. In planning and executing their programmes due regard will have to be paid to the needs of the constituent villages on the one hand and of the next bigger units to which they belong on the other hand, in this way bigger and still bigger units will function till the naional level is reached or perhaps upto the world organisation.

The set up proposed here may be briefly summarised as follows:

1. Welfare is indivisible but relative emphasis on different fields of human endeavour must. vary with time and place. This principle will be the basis of planning and specially of organisation of services.
2. The priorities should be determined objectively through scientifically conducted intergrated surveys embracing man, society and environment. They will bring out community picture and causal factors.

3. The decision regarding priorities must finally rest with the would be beneficiaries who should be fully enlightened with the results of the surveys. On them must also primarily rest the responsibility of carrying out schemes.
4. Beginning with the village, suitable territorial units of increasing size have to be worked out on rational basis which may not always correspond with the present union, subdivision or district boundaries and which may need changing.
5. There will be a village council based on adult franchise. Through this council every man and woman will exercise his or her rights and responsibilities of citizenship. It will perform all or most of the functions of the government but its plan of work must fit in the general scheme of the next higher unit. Paid resident polytechnical agents, a man and a woman who have been specially trained in essential rural functions will act as guides and philosophers, as business managers and organisers, and as liaison officers between the villagers and experts in various fields.
6. Each peripheral territorial unit consisting of a group of villages will have a council elected through indirect franchise which will be charged with similar functions in respect of the problems relating to and arising out of the unit organisation as a whole. Each unit will have a polytechnical board and a set of institutions according to requirements. The members of the board will have joint responsibility for service to the unit and its constituents. They will assist the council in the solution of all problems. In case they present difficulties which are beyond their capacity, they will be referred to similar polytechnical boards and institutions attached to the next bigger territorial unit.
7. Similar councils, polytechnical boards and institutions will be provided for each bigger territorial unit till the national unit is reached.

Where do the scientist come in? They come in at all stages, as citizen, as members of the polytechnical boards, as officers of the institutions and as designers and interpreters of surveys to the common man. They have grave responsibilities. They have to isolate problems of different magnitudes and complexities, carry out investigations and researches to solve them. The rate of progress will largely depend upon their efficiency, team work and spirit of service. They will have enough scope for the utilization of their talents in the solution of problems related to actual life. This does not mean that pure science will have no place. Without the development of pure science many problems arising out of actual life will remain unsolved. What is pure science to-day, is applied science to-morrow. Universities will provide enough scope to works in pure science, without them they would languish.

As regards industries, these will be established at various levels, with dual purpose. First to provide the needs of the community and secondly to employ people who cannot be absorbed in cultivation, trade and services. The prices of consumer goods specially those considered essential will be fixed according to the purchasing capacity of the people whether they yield profit to the producer or not. In the latter case the industries shall be run or subsidised by the Government. Research and organisational efficiency shall be advanced to the utmost limit with a view to bringing down the production costs to economic basis. When this has been accomplished the industry may if necessary be made over to private enterprise with appropriate safe guards. On the other hand the general economic level and the purchasing power of the people will rise enabling them to progressively convert luxuries into necessities.

In the beginning of this talk we included the word happiness amongst our objectives. This was purposely done in order to draw special attention to the fact that mere rise in the standard of living does not mean happiness. Besides physical comforts which are urgently required for the masses in this country, health and culture are essential ingredients of happiness. But for the great cultural heritage, life would be unbearable of a great many people. Cultural enjoyment is as necessary for the poor village-folk as for the sophisticated town dwellers. It is wrong to think that cultural advancement and recreation need necessarily be expensive. It is more a question of vogue than of money. The polytechnical boards should, therefore, include artists who would give a fillip to the languishing talents in our villages and help in making village homes more beautiful and the rural life fuller and richer. What applies to the villages should apply equally to industrial settlements and towns.

We feel optimistic about the response of science to the challenge of rural problem but can the same be said of governmental organisation. If the principles ennunciated here are acceptable to both there is no reason why a beginning cannot be made immediately by organising a pilot experiment for which a district may be set aside. A board of scientists, economists and administrators may take full charge of it, subject to the reservation by the Government,

of the right of audit, of inspection and comments on periodical or special reports. Such an experiment to be of real value must be within the financial possibilities of the rest of the country.

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INDUSTRIAL UTILIZATION OF ATOMIC POWER IN INDIA

(Continued from the last issue)

POWER PILES IN INDIA

We have seen that due to the high cost of producing suitable fissionable materials, and of construction of safe chain reacting piles, it is not possible even in the U. S. A. to generate atomic power to compete economically at the present stage of development, with coal and oil power plants. The question may be asked whether under such conditions it is worth while considering plans for the erection of atomic piles in India for power generation purposes. In the introduction we have stated our reasons for the desirability of planning for such an end.

Assuming that it is desirable to erect and run atomic power plant in India, we may consider different ways in which this aim may be realized. Here again we shall get some suggestions if we consider how thermal and hydroelectric power plants are obtained and maintained in this country. Here two factors are involved, *viz.*, the source of power, either fuel or water supply, and the machinery which generate mechanical and electrical power from them. There are three different ways in which the desired object can be carried out, *viz.*, *(i)* both the fuel and machinery can be imported from abroad; included in this category are the heavy Diesel engines, oil burning power plants and motor vehicles.

(ii) The fuel and water supply can be procured locally, but the machinery is imported from abroad: coal burning power plants, steam and electric locomotives and hydroelectric power generators.

(iii) Both fuel and machinery are of local production. So far as is known to us only low h.p. electric and oil engines are manufactured in this country. The latter however use mostly imported fuel. It is not a matter of congratulation to us that after a century of use of imported locomotives, plans have been only recently sanctioned for the manufacture of a limited number of locomotives in railway workshops in this country.

A similar classification may be made of different methods of establishing atomic power plants in India. They are *(i)* to import both atomic fuel and atomic pile with the necessary heat engines from abroad. Such a plan does not appear to be feasible, as it is difficult to conceive how in these days of international rivalry in the use of atomic power for war purposes, any country producing atomic fuel will be prepared to supply it to a foreign country. Such fuels if supplied will be denatured, *i.e.*, its content of U 235 or Pu 239 is made so low compared to that of the dilutant U 238, that while still retaining its utility as atomic fuel, it is not suited for atomic warfare purposes. It has been suggested however that from such fuel, by means of long complicated processes of thermal diffusion or by magnetic separation, the fissionable material may be separated and used for war purposes.

(ii) to chemically process the atomic fuel from local supply of uranium and thorium ores, and use it in atomic pile machinery imported from abroad. At the sametime to proceed with the training of the staff required for the control and maintenance of the machinery employed, and for the processing of the fissionable and moderator materials. This plan was suggested by a foreign expert with whom the problem was discussed. In his view, even an industrially advanced country like Great Britain finds it very difficult to manufacture such machinery; so it would be better if for the present India concentrated on the processing of her fissionable materials, which she could use for barter, for procuring the necessary machinery, with countries manufacturing atomic piles.

(iii) India will not only produce and purify her own fissionable materials, but also build her own atomic piles, importing so far it is necessary, com-

ponent parts of machinery, constructional materials and detecting and controlling instruments.

We may consider (*ii*) as an intermediate step in the achievement of our final aim as given in (*iii*). We can now proceed with the discussion of our resources in materials, in scientific and industrial personnel, and of measures which have to be taken to realise our final aim. It may stated at once that no immediate sensational results should be expected, and that we should be prepared for long range planning and development.

Raw Material—Uranium.—We have seen that no chain reacting pile can be worked without using a large quantity of uranium as starter. According to present information, ores containing high per centage of uranium oxides, like pitch-blende, of amounts required to start a pile, are not available in this country. As in other countries, these is a fairly wide distribution of low grade ores as in pegmatitic rocks. Sometime it occurs in association with metals which are of economic value. It has been mentioned previously that in many countries uranium is associated with vanadium. We have in this coutury one of the richest deposits of iron vanadium ores (average content of samples V_2O, 0·8 to 4%, Fe 50 to 60%, TiO_2 4–20%) and isolated observations have revealed traces of radioactivity in some of the mineral specimens. According to *Chem.* and *Eng. News* (24, 2030, 1940) an almost in exhaustable deposit of titanium has been discovered in Arkanas, U. S. A. Samples taken from such deposits show a thorium content of 0·5% and of uranium of 0·1%. It is expected that the source may make U. S. A. independent in the development of atomic energy. If vanadium oxides and vanadium steel is manufactured from our Indian ores, then it may be possible to extract uranium, as by product from the residues, comparatively cheaply. It is also reported that small concentration of uranium is associated with thorium in monazite. It is expected that the proposed survey of uranium bearing rocks by the Geological Survey will disclose new deposits of uranium bearing rocks.

Thorium.—India contains probably the richest deposit of thorium in monazite sands. Unfortunately most of the deposits occur in Travancore, whose Dewan is trying to proclaim the independent status of the state. It has been suggested that the proposal is finding backing from certain interested powers, and the occurence of monazite deposits may have some bearing on this. A resolution is reported to have been adopted by the Atomic Research Committee last February, drawing attention of the Central Government to the concession granted by the Travancore State to some British firms for the export and processing of thorium-bearing minerals. The Committee has stressed the desirability of limiting the export in bulk of such minerals or of thorium metals obtained from them. It is to be hoped that beter counsels will prevail, and Travancore will decide to remain in the Indian Union.*

Graphite.—Both India and Ceylon possess rich deposits of graphite. In the U. S. A. graphite rods used as moderators are prepared from petroleum coke. Whether the mineral graphite will reach the same degree of purity remains to be tested.

Chemical processing.—After the supply of required quantities of uranium and thorium ores has been assured, the next step is to proceed with the extraction of the metals and for their purification to the required degree. The cost of extraction and purification will represent one of the limiting factors in the economic utilization of atomic fuel at competitive prices. In the U. S. A. as a result of team work between scientists and industrial concerns, the cost of manufacture of pure uranium metal was reduced from $1,000 to $22 per lb. We are relatively backward in our experiences of methods of separation and extraction of rare metal (which till now included uranium and thorium), and of the metallurgy of nonferrous metals. According to our information, the only place where investigations on the separations of rare earth metals is being carried out, is in the inorganic department of the University College of Science, Calcutta. There was a boom in the study of physical chemistry in most of the Indian Universities, and a consequent neglect of inorganic chemistry. The National Chemical Laboratory and the inorganic laboratories of Universities should be invited to cooperate in such investigations. Chemical engineering of a high order, at present not available in this country, will be required to utilize the methods worked out in the laboratories for the manufacture at competitive prices of pure metal from the ores.

Thorium as fuel for atomic reactors.—Probably in some of the countries like the U. S. A. and the United Kingdom, data have already been collected relating to the conditions under which a reactor started with uranium metal can be subsequently maintained by thorium, and how in such piles, analogous to the production of Plutonium from Uranium, a fissionale metal U 233 is synthesized from Thorium. It is essential that similar fundamental investiations should be encouraged in this country. We should not be dependent on foreign countries, for the supply if at all possible, of such data. Absence of such knowledge will hamper our bargaining power in the barter of thorium metal for atomic pile machinery.

* Since this article was sent to the Press information has been received that the Travancore State has decided to join the Indian Union under certain defined conditions, whose implications require further elucidation.

The physical investigations will be aimed at collection of experimental and theoretical absorption coefficient data for neutrons of different velocities, in uranium and thorium metal and in the moderators. For such purpose experimental piles require to be constructed in which the critical size, effect on the neutron production factor of the distribution of fissionable metals and moderators, can be studied. Such informations gathered in countries where atomic piles are working, are not published for security reasons. For such investigations large neutron supply sources are indispensable, and will require the aid of cyclotrons and high voltage electrostatic generators.

Along with such investigations, the medical hazards associated with the generation of intense ionizing radiations in the atomic piles should be investigated, and protective measures devised. The fission products are themselves very radioactive, and are being utilized as tracer elements in many biological and chemical investigations and for curative treatments. Similar work can also be started in this country.

Atomic Research in India.—We will now consider what steps have been already taken in this country to advance atomic research. Towards the end of 1045, the President of the Council of Scientific and Industrial Research appointed an Atomic Energy Committee with the following terms of reference (i) to explore the availability of raw materials capable of generating atomic power, (*ii*) to suggest ways and means of harnessing the materials for production of atomic energy and (*iii*) to keep in touch with similar organizations functioning in other countries and to make suggestion for the coordination of the work of this committee on international basis.

The Committee included amongst others Prof H. J. Bhabha (Chairman), Prof M. N. Saha, Mr D. N. Wadia, Mineral Adviser to the Central Government, and Sir S. S. Bhatnagar, Director, Scientific and Industrial Research. The Committee has met twice since its appointment, in May 1946 and February 1047. From the beginning the Committee was anxious to secure the co-operation of the Travancore State and it appointed a sub-committee for this purpose. It also appointed another sub-committee to draw up concrete proposals for a geological and physicochemical survey of uranium bearing minerals in India. A member of the Geological Survey of India, who has been deputed to study methods used for such surveys in Canada and the United States, has been co-opted a member of this sub-committee which has however, due to the frequent absence of this member, not so far been able to meet. The survey proposed to be undertaken appears to be too vast to be carried out by a single member of the Geological Survey. We suggest that efforts should be made to enlist the co-operation of institutions and universities, where similar work is being done, including the setting up of portable Geiger Muller counters, which are considered to be indispensable for field survey of radioactive rocks minerals.

Having thus dealt with the questions relating to the survey of 'raw materials capable of generating energy', the Committee which now became known as the Atomic Research Committee, "considered the general problem of atomic research in India, and made the following general recommendations for the period immediately ahead, till the period is reached when the development work on the release of atomic energy can be started".

(1) The universities should be encouraged to give elementary instruction in the theory and the experimental technique of atomic physics as far as possible.

(2) The existing centres of atomic research viz., the Palit Laboratory of the University College of Science, Calcutta, the Bose Research Institute and the Tata Institute of Fundamental Research should be strengthened.

(3) The Tata Institute of Fundamental Research should be made the centre for all large scale programmes of atomic research in future.

The Committee also recommended the payment of certain initial grants to the three Institutes mentioned under (2), and also a capital grant for the establishment of a Betatron capable of producing electrons of energies up to 2×10^{8} e v, to the Tata Institute. It was expected that with such high energy electrons, it would be possible to produce under laboratory conditions, the fundamental particle mesotron and to study its properties. The Chairman announced that during his contemplated tour to Europe and America, he proposed to visit the laboratories and industrial firms engaged in the development of high energy charged particle accelerators. At the second meeting he presented a report of his visit abroad based on which, the Committee decided to postpone decision on the purchase of such machinery, pending clarification of the situation regarding the performance of different types of accelerators, all of which are in the development stage.

It will be seen that so far not much work has been done by the Committee on the utilization of Atomic Energy. For one thing the Committee meets too seldom, resulting in a lack of continuity in their deliberations and in their effort to initiate new schemes. So far no concrete proposals have been considered by the Committee on the development work and investigation necessary 'for the harnessing of materials for production of atomic energy'. In

the effort to secure the cooperation of the Travancore Government for the reservation of thorium containing minerals, sufficient attention has not peen given to the more important problem of research and development work necessary for the construction of a Uranium reactor pile. Unless this problem is solved, and also the next one of finding how far thorium can replace uranium in such pile, there cannot be any question of utilizing thorium solely as fuel in atomic reactors.

Recently however an important decision has been taken by the Government of India, to replace the Atomic Research Committee which functions under the Board of Scientific and Industrial Research by a Board of Research on Atomic Energy. This board will be directly under the control of the Council of Scientific and Industrial Research, and will be entrusted with the carrying out of the following main functions.

(*a*) To plan, finance and carry out Atomic research and development throughout India.

(*b*) To explore the availability of raw materials connected with the generation of atomic energy and to advise Government on the control, utilization and export of such raw materials in India.

(*c*) To provide the machinery for co-operation in matters of atomic energy, research and development with the corresponding bodies, and to advise Government on any agreements with foreign powers that may be necessary for this purpose.

(*d*) To appoint Committees and take all other steps in furtherance of the aim of developing atomic research and energy to the fullest extent in India

It has also been agreed with the consent of the Travancore Government, to met up a joint Committee for research and development of atomic energy from Travancore minerals. This Committee will consist of nine members, of whom six will be from the Atomic Research Board, and three will represent the Travancore State. We do not know how this Committee will function in view of the recent attitude of the Travancore Government.

We suggest that when the Atomic Research Board meets it will be consider the desirability of setting up two Committees, one on Atomic Research and the other on Atomic Energy utilization. The functions of the first named Committee will be to deal with investigations on fundamental problems of nuclear physics and cosmic radiation. The function of the second Committee will be to deal with investigations on utilization of nuclear energy. In the present article we are interested in the work of the second committee, which we suggest should carry on its work through three subcommittees for the present.

(*i*) A geological and physicochemical subcommittee for the survey of rocks and minerals containing fissionable metals and for the determination of uranium and thorium in them. The majority of such rocks will be of low uranium content, and amongst them special attention should be directed to those which are either being at present utilized or can be utilized for the metallurigical extraction of a main constituent of industrial importance. If will also survey deposits of high grade graphites.

(*ii*) A chemical processing subcommittee whose function, will be (*a*) to investigate methods for the recovery of uranium from waste products of metallurgical processes mentioned in the previous para ; (*b*) to investigate and develop methods of using crude oxides of uranium and thorium as starting materials, for the production of the corresponding metals in the required grade of purity. Similar investigations on purification of graphite will be undertaken.

(*iii*) A subcommittee for investigations of the physical processes underlying the construction of a uranium reactor pile, and of the recording instruments used in them. The aim of this subcommittee will be the erection of an experimental uranium reactor pile.

Another investigation to be undertaken by the subcommittee will deal with the fission of thorium by fast neutrons and the production of new elements from thorium by slow neutron absorption, which are fissionable under slow neutron absorption. While a great deal of information is available on the production of fissionable elements like Neptunium and Plutonium from U 238 very little is known about similar products Pa $^{233}_{91}$ and U $^{233}_{92}$ from Thorium. Probably such informations are being kept back for security reasons.

As positive results from investigations initiated by the different subcommittees accumulate, it will be necessary to widen the scope of investigations taken up by them : "Basic nuclear reactions and the theory of nuclear fission belong to the field of physics, but detailed study of problems of construction of an atomic reactor for power production include major contributions from chemistry, chemical engineering, metallurgy, electrical and mechanical engineering".

It will necessary for the Board from time to time to suggest to the University Grants Committee and to the Higher Technical Education Committee, to introduce and finance new courses of study in subjects which are connected with the construction of atomic reactor, and also to invite the cooperation of a much larger number of universities and research institutions in the developmental work. At present only three research laboratories are associated with this work.

For comparison we give an account of the newly created Atomic Energy Commission in the U.S.A. to show how seriously and energetically the problem is being considered there. Atomic piles have been started or are under construction in other countries like Canada, England, Sweden, France, but information available regarding them are not so detailed.

The U.S.A. commission consists of five members with D. E. Lilienthal as chairman. They are responsible for the formulation of Government policy on atomic enery. Its function will be 'assuring national defense and security (and directing) the development of atomic energy in such a way as to improve public welfare, increase the standard of living, strengthen free competition in private enterprise and promote world peace.'[8] The work of the Commission will be carried through five regional organizations.

(1) Clinton Laboratories at Oakridge, worked by Monsanto Chemical Co., for Power pile and Radio biology.

(2) Hanford Engineering Works, Pasco Washington, worked by G. E. Co. Several designs of piles for generation of electric power are being tried. The Company will also operate power plant laboratory at Schenechtady for study of nuclear power production and ship propulsion.

(3) National Laboratory on Long Island to be operated by a corporation of *nine Universities* in the New York area. Will engage in a broad field of research.

(4) Los Alamos Laboratory, where military applications are under investigation, including biological effects of radiation, power development and atomic weapons.

(5) Argonne National Laboratory at Chicago: research on power plants, biological problems medical application, chemistry of fissionable materials and their properties. *Twentyfive midwest universities* coperate in the Argonne laboratory. In addition more than a score of contracts has been let to universities and research institutions in order to foster private research in medicine, chemistry, metallurgy, ceramics and all phases of nuclear physics.

From what has been discussed above, it is clear that plans for utilization of atomic fuel for industrial purposes in India must be long range ones. It will require the provision of new equipments and introductions of new courses in nuclear physics and electronics in our universities; co-operation between them on large scale research programmes, introduction of specialized courses in chemical and electrical engineering in technological institutions and development of new metallurgical and power engineering industries. Without raising the level of industrial efficiency of the country, utilization of atomic energy for industrial purposes by means of local agencies will not be possible. Whether it will be possible to use locally processed atomic fuel on imported atomic pile machinery, will depend on how the international relations develop during the next ten years.

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DEVELOPMENT OF OPTICAL GLASS INDUSTRY

ATMA RAM AND Y. P. VARSHNEY,
CENTRAL GLASS & CERAMIC RESEARCH INSTITUTE, JADAVPUR, CALCUTTA

THE total annual production of glass in the world to-day runs into millions of tons, and surprisingly varied are the forms in which it finds wide application. But out of this vast outturn there is a very small fraction, less than even 1/10th of 1 per cent, which though negligible in quantity, vies with and perhaps even overshadows the rest in importance. This small fraction is optical glass, or strictly speaking optical glasses—because there are so many of different compositions and varying optical properties. Exacting in requirements and difficult to produce, they form a heirarchy of their own in the realm of glasses.

Optical Glass in Peace and War

It has been said that 'knowledge is power' and the power that man has acquired in harnessing the resources of nature to his ends is based on scientific knowledge. But in the acquisition of that knowledge no single substance has played a worthier role than optical glass. It forms the vital components of instruments with which man probes the secrets of nature in the laboratory as well as in the field. The telescope and the microscope are but two outstanding and well-known inventions based on the optical properties of glass. The spectrograph is yet another instrument which opened vast fields for scientific investigation and research and is now proving to be equally invaluable in industrial work. In fact, modern science and technology and industrial plants require innumerable instruments and appliances and the majority of them use optical glass in some form or other. The astounding precision and sensitivity of many of these is largely dependent on the high quality of optical glass components used in their manufacture.

Being the principal material of numerous instruments used in military operations, optical glass has become a key and strategic material of modern warfare. It is indispensable for numerous sensitive devices necessary for field operations and defence industries. Amongst a host of these one need only mention the army and naval telescopes and binoculars, range finders, dial sights of field artillery (this device enables a gunner to take aim on a target he cannot otherwise see), optical systems of tank and anti-aircraft guns, periscopes of submarines etc. The wonderful mechanism, bomb sight, developed in America, and so often heard of during the war, is a complicated mechanism of optical glass combinations. In modern warfare if the efficacy of the explosive determines the extent of destruction and carnage, the employment of sensitive optical devices guarantees the accuracy of the operation. In short, optical glass is the eye of the Army, the Navy and the Air Force.

To the common man, optical glass provides an indispensable aid in the form of spectacles lenses and to many it is almost the tool of the bread winner. The uses of optical glasses are far too numerous and indispensable to be discussed in a short article.

Early Development

Such being the importance of optical glass in the welfare and prosperity of a nation, both in times of peace and war, it is natural—specially after the lessons of the war of 1914-18—that sustained efforts have been made in different countries to produce optical glass and optical instruments in sufficient quantities. In view of its strategic importance, governments of several leading countries have particularly taken care to see that the standards of production both in quality and quantity are such as to make them self-sufficient and independent of imports. In fact, it is the constant search for new glasses of varying optical properties necessary for designing more and more perfect lenses to give undistorted images in optical instruments, which has led to extensive studies of the effect of incorporating new ingredients in the glass composition. And it is on the strength of such studies that our knowledge of glass technology has largely grown.

Weight for weight, optical glass is the costliest of all glasses. The very high degree of purity of the ingredients used in its manufacture, the perfect or optical homogeneity of the product and the precision necessary in the subsequent finishing operations are some of the indispensable characteristics of optical glass. It is the accomplishment of these qualities involving the use of complicated devices that has made its production more difficult and costly than that of ordinary glassware. For instance, ordinary transparent sheet glass is good enough for glazing windows in spite of even some waviness on the surface, but a piece of it ground and polished into the shape of a lens would be utterly useless. Such a lens would not give a true image of the objects seen through it, because the glass is not free from strain

and homogeneous enough. Besides, the image would lack brightness due to appreciable absorption of light in the glass. Due to the difficult nature of the operations involved in its manufacture, its production has still remained confined to a few concerns in some of the industrially advanced countries, who closely guard their standardised practices as secrets often covered under patents.

The invention as well as development of a homogeneous glass suitable for optical purposes was due to the Swiss watch-maker P.L. Guinand, who introduced about 1790 the process of stirring the molten glass. Subsequently his descendants continued the work in France and later associated with others to set up the optical glass making firm of Parra Mantois et Cie of La Vesinet, Paris, while Bontemps, an associate of theirs at one time, joined Chance Brothers in England.

It was however almost a century after the introduction of the stirring process that manufacture of optical glass was greatly developed and established on a sound basis as an industry in the latter part of the nineteenth century by the pioneer and classic work of Otto Schott in Germany. The key to this lay in the scientific investigations of glasses of varied compositions made by Schott and his collaborators. This was supported by the examination of their optical properties by Ernest Abbe, the noted physicist, and the valuable results of these researches were made available to the world through the collaboration of the well-known firm of optical instrument makers, Carl Zeiss of Jena.

New Components of Glass

Till that time the older types of optical glasses were chiefly the ordinary crowns, *i.e.* alkali lime silica glasses, and the ordinary flints *i.e.* glasses containing lead. In both the types the dispersion increases with the refractive index, but there is irrationality of dispersions in different parts of the spectrum with the result that only fair achromatism can be obtained.

The work of Abbe and Schott besides yielding an immense wealth of data developed a host of new glasses incorporating elements such as boron, phosphorus, barium, fluorine and zinc. Whole series of borosilicate crowns, barium crowns, barium flints, borate flints, borate and phosphate glasses, in which the character of the dispersion varies from type to type, were made. From these glasses pairs could be selected such that their dispersion ratios were more in accord than in the older ones and better color correction in lens systems could be attained. This work led to the anastigmatic lens and the apochromatic objective.

In January 1884, the firm of Zeiss, with Abbe and Schott, started the erection of the Glastechnisches Laboratorium Schott und Genossen. This had also the support of the Prussian Government in as much as a grant of M. 60000 was given to it at the instance of the then Director of the Royal Observatory at Berlin. In the course of years "Glastechnisches Laboratorium" gradually dropped off leaving the name "Scott und Genossen" by which it became famous all over the world. Writing about this works or technical laboratory Prof. W. E. S. Turner remarks:

> "The founding of the glass technical laboratory Schott und Genossen was an event which was without real parallel in the history of glass-making. The success of the Swiss watch maker P. L. Guinand, in working out a process for melting homogeneous optical glass in larger masses than hitherto attained, certainly led to small works being established for exploiting the process both at Les Brenets in Switzerland and also in conjunction with Utzschneider and Fraunhofer at Benediktbeurn in Bavaria. There may at rare intervals have been some other parallel during the history of glass-making, but it must indeed have been rare. In the case of Schott the new works were not merely to make glass of good quality in the sense of homogeneity and clarity, but also to introduce a whole new world of glasses. There was no intention in the factory to make glasses of existing types."

The first catalogue of the commercial products of Schott und Genossen was issued in 1886 but till 1891 its growth was very slow; the staff consisting at that time only of 19 persons. In the following years, however, as the activities were spread over a wider range of glasses, expansion became very rapid. Referring to it in 1909, Prof. E. Zschimmer, who was for many years associated with Schott und Genossen at Jena, wrote:

> "It stands to-day at the middle of a great concern of 1,000 people, of whom 30 suffice to make the optical glass for the whole world".

The quantity of glass supplied annually to Germany and to the rest of the world, particularly to America, France and England, was about 50,000 to 60,000 Kg. In 1913, it had an establishment of about 1300 which continued to grow in the post-war years after 1918. By 1934, of optical glasses alone the Schott lists contained no less than 154 types of colourless and 58 types of coloured glasses.

The development and success of the German optical glass industry was so unique that till the outbreak of the war it enjoyed almost a world monopoly, and even after the first world war, though optical glass manufacture had been taken up on a large scale in Britain and the U. S. A., German optical glass goods continued to be considered the best in the line and it was hard to overcome the prejudice against such products from other countries.

Optical Glass in other Countries

When the war broke out in 1914 and there was consequent stoppage of supplies of optical glass from Germany, both in view of her belligerancy as well as the demands of the German army, the allied powers were exposed to great risks due to want of this strategic material. The problem was so serious that a great drive was made by the British ordnance production authorities with the co-operation of scientific departments and glass manufacturers, in order to produce within the country optical glass for the prosecution of the war. Its strategic importance as an essential munition, determining to a very appreciable degree the very course of the war, was never realised before more than at that time.

Till 1914, Great Britain imported about 90 per cent of her optical glass, most of which came from Germany alone. Only one firm *viz.*, Messrs. Chance Bros. of Birmingham had since some time past been making this vital material and until early in 1916, *i.e.* for nearly the first two years of the war then restricted production was the only source of supply available to British instrument makers. Early in 1916, the advances in aerial photography and the rapid expansion in the strength of the fighting forces necessitated by the course of the war increased the demand of optical glass enormously. It became imperative for the British Government to look for other sources of supply and co-operation in this work was sought from Messrs. Wood Bros. Glass Co. Ltd. of Barnsley. In June 1916, operations were commenced in the Derby works of this firm and simultaneously a vigorous study of the scientific aspects connected with the problem was started under Dr C. J. Peddle. This involved not only the working out of suitable batches with the available raw materials but also detailed investigations into the most satisfactory conditions of melting, stirring, cooling, moulding and annealing. It goes to the immense credit of the British workers that within the short space of 3 years some 70 different types of glasses comprising almost all those used in pre-war years, as well as some new ones were successfully developed in spite of the enormous work involved. The papers published by Dr Peddle on the basis of studies of the effect of composition on the density, optical constants and stability of optical glasses form one of the most important scientific contributions on the subject.

America too, although not a belligerant in the beginning, was no better placed than Great Britain and when she entered the war she lacked not only supplies of optical glass but also the information regarding the processes of its manufacture. There was no trained personnel to handle this work and even the knowledge of sources of supply of raw materials of the requisite quality was but scanty. The position is summed up in the following words of Col. C. E. Wright of the U. S. A. Ordnance Reserve Corps.

> "The general situation may be summarized by stating that when we entered the war we not only lacked a supply of optical glass, but we lacked information regarding the processes of its manufacture. We had little knowledge of the quality and sources of supply of the raw materials required. We lacked manufacturing capacity and a trained personnel to handle the problems."

In the face of such a situation in April 1917, the U. S. A. Government appealed to the Geophysical Laboratory at Washington for assistance in the manufacture of optical glass and an approach was made to the Bausch & Lomb Optical Co., Rochester for co-operation.

The scientific staff from the Geophysical Laboratory commenced work at the Bausch & Lomb plant in April and May 1917 and by November 1917 the work had been mastered and carried to the stage of large scale production. In another month, *i.e.* by December 1917 the scope of operations was extended and the men from the Geophysical Laboratory who had worked at Rochester, were distributed to take over control at the Pittsburg Plate Glass Co. and the Spencer Lens Co. Thus three plants actively took to optical glass making and between them they turned out about 95 per cent of the optical glass made during the war by U. S. A. while a small quantity was made by Keuffel & Esser Co. who successfully carried it out independently--and by the Bureau of Standards at Pittsburgh.

A number of eminent workers including Drs Allen, Bowen, Morey, Hostetter, Washington, Fenner, Zies, Adams, Williamson and others headed by Dr A. L. Day, Director of the Geophysical Laboratory at that time, were associated with this work. These names are famous now -Bowen, Morey and Merwin are well known for their studies of phase equilibria of silicate systems ; anyone who has chemically analysed glasses and silicates is familiar with the work of Washington and Allen and Zies ; Adams and Williamson's work on the annealing of glass has proved of immense importance. Most of these valuable researches were either inaugurated in the course of this work on optical glass manufacture or were started or continued later as a consequence of it.

The principal glass types, each comprising a series of glasses of varying optical constants, manufactured in quantity in the United States at that time were borosilicate crown, ordinary crown, dense barium crown, light medium and dense flints, barium flint and extra dense flint. Of these, the last was produced only by the Spencer Lens Co., while the Bausch & Lomb Optical Co. produced only the borosilicate and ordinary crown, and the light

medium and dense flints. By October 1918, the total monthly production had risen to 40 tons—with a possible increase of another 20 tons—which was enough to meet all war time demands of the country.

Production during Second World War

These organised and intensive efforts to develop the optical glass industry in England and U. S. A. under the stress of war conditions in 1914-18 were continued in the post-war period and the industry has been firmly established in these countries. Such development proved of immense value during the second world war. Writing about the British optical glass industry the following words of Mr Thomas Martin, Deputy Director of Instrument Production, British Ministry of Supply, are of interest.

"The state of affairs in 1914-18 was very different, and the fact that between the two wars the position has been so completely reversed is a testimony to the enterprise of the manufacturers, to the wisdom of the Government policy of judicious encouragement of optical glass research and manufacture, and to the fostering care of the Optical Glass Committee sitting at the Admiralty under the Chairmanship of the Director of Scientific Research, Mr C. S. Wright."

According to Mr Martin, the average annual production of first quality optical glass in Britain during 1942-44 was 273 tons—indeed a large quantity by optical glass standards—enough to meet all home demands and leave some margin for export to their ally, America. An idea of the large quantities of optical instruments produced in Britain during the war may be formed from the following typical examples.

Binoculars	6,20,000
Telescopes	3,94,463
Dial sights	32,310
Directors	19,410
Tank Periscopes & Episcopes	3,30,809
Clinometers	94,170
Microscopes	19,285

However, in spite of such a satisfactory position in England and America the allies were particularly keen during the war years to set up alternative sources of supply of this key material. Industrial areas in Great Britain were vulnerable to aerial attacks and British production of optical glass could have been severely impaired by enemy bombing. Immediate co-operation with the British optical glass industry was therefore arranged in order to develop this manufacture in Canada and the progress of this venture is best described in the following words of Dr W. M. Hampton of Chance Bros. Ltd., England.

"A Government company, Research Enterprises Limited, was formed during 1940 to erect a factory in Toronto for the manufacture of various instruments, and in some cases the raw materials which were necessary for them. When it was decided, about October 1940, to commence the manufacture of optical glass there, Colonel W. E. Phillips, the President of the company, approached Chance Brothers & Co., Ltd., through the Canadian and British Governments, with the suggestion of co-operation. As a result of that approach I visited Toronto in November 1940 in order to ensure the most rapid development of the new undertaking. The result was that an arrangement was reached whereby the fullest information concerning the manufacturing technique was transferred to the Canadian factory, and certain physicists from Canada came to England and were trained in the art and technique of making optical glass. These physicists remained at our works for some two to three months and were attached to our own personnel, so that they had the fullest opportunity of learning all that we could teach them about the manufacture of optical glass. A number of other people were recruited in this country, some from the Canadian Forces here and some from our own staff, and were given a special intensive course before being sent to Canada for starting up the new process. Further, when manufacture began, one of our technicians went to Canada for some months in order to assist in overcoming the initial difficulties, so that the closest co-operation was maintained and is still being maintained. When it is realized that in November 1940 the optical-glass plant consisted of merely the walls of what was to be a factory, and that the first melting was successfully made in June 1941, and that by the end of 1941 a considerable number of meltings of first-quality glass had been made, it will be realized that, owing very largely to the enthusiasm and drive of the Canadian executives, a very remarkable result has been achieved. There has throughout been the closest co-operation between the Canadians and ourselves, and it can be said that there has been no serious hold-up or difficulty in transferring the manufacture from this country to that."

Yet another country which took the opportunity of developing an optical glass industry during the war is Australia. Australian Consolidated Industries Ltd., successfully produced optical glass in 1941-42 in a Sidney factory which is claimed to be as good as the best optical glass made elsewhere. Assistance to start this work was taken from the U. S. A. National Bureau of Standards who provided all the necessary data at the request of the Australian Federal Government.

Apart from the large scale production which was necessary to meet war time needs, a great deal of attention has been devoted to scientific research connected with optical glass and the value of this can be gauged from the notable advances made.

New Glass Compositions

A breakaway from the traditional glass making compositions has been made by Kodak in producing glasses of unusually high refractive index (as high as 2·0) and relatively low dispersion by using constituents such as oxides of titanium, tungsten,

tantalum, lanthanum, thorium, yttrium, colombium, and hafnium, and eliminating silica altogether or keeping it below 1 per cent. Then again, some of the Chance glasses that appeared during the war, contained rare metallic oxides and they marked a distinct advance in optical properties over the pre-war glasses. As such new glasses (having high refractive index) suffered from the defect of high surface reflection the process of "blooming" the surface or making it non-reflecting by using surface coatings of magnesium and aluminium fluorides has been developed.

The possibilities of these new Kodak and Chance glasses have perhaps not been fully investigated yet and although over fifty patents incorporating them are reported to have been taken by English and American opticians in Great Britain alone, it is premature to estimate the extent of their use.

NEED IN INDIA

In developing their optical glass industry within the short space of a few years, Canada and Australia have adopted the practical and expeditious way of seeking co-operation from outside. This has enabled them to save much time and reduced greatly the enormous amount of preliminary work and even expenditure which would have been otherwise necessary without any guarantee of complete success. So far no organised effort can be said to have been made in this country to establish this vital industry, but there seems no reason why it should not be possible to do here what has so successfully been carried out in Canada and Australia.

In India, as a result of increasing war demands, considerable work in the processing of optical glass such as grinding, polishing etc. was done at the Mathematical Instruments Office, Calcutta, and the Survey office laboratories at Dehra Dun and a number of workers were also trained, but all the raw optical glass was imported. Some scientific investigations were also carried out under the auspices of the Council of Scientific and Industrial Research. Being a strategic material, so essential for the defence of the country, a special responsibility to ensure its production rests with the State and though circumstances such as those during the war which would have helped in securing good cooperation, no longer exist, a serious effort should be made in this direction and the argument that the requirements of optical glass were so small that they could profitably be imported should not produce a feeling of complacency.

AUSTRALIA PLANS FOR A POPULATION OF TWENTY MILLIONS

K. BAGCHI,

CALCUTTA

LARGE scale national reconstructions in modern days are based not so much on land as on water. With the latest technique of the multiple uses of running water the entire economic structure of a country can be overhauled and changed beyond recognition. We are happy that the members of the Indian National Government have recognized the significance of technological revolutions in stabilising national revolution and have not hesitated to foresee the possibilities of multipurpose developments of river valleys. Such developments are not peculiar to the U.S.S.R. and U.S.A. alone, even Australia is forging ahead with bold schemes of development. It would be interesting for us to acquaint ourselves with what is happening in this remote corner of our 'One world'.

Australia is one of the least favoured tracts of Nature. On a world map, she looks imposing enough to be classified as a continent. She even covers an area of 3 million square miles, almost one and three quarters larger than India, and comparing favourably with the U.S.A. But her population is only 7 millions. This meagre population surely indicates the scanty resources of Australia. What is the reason?

A map depicting the population distribution of Australia superimposed on the rainfall map will answer the question. About 70 per cent of Australia's total population is confined to the South-East, in the States of New South Wales and Victoria covering only 13 per cent of Australia's total land area. Of the remaining population, 50 per cent live in the capital cities in the other four provinces of the Dominion. Barring the South-East and the coastal fringes, the central and the western portions of Australia are almost completely barren.

This barrenness is entirely due to the scarcity of water. It has been estimated by Major Powell of the United States of America that the limit of rainfall for successful agriculture without irrigation is 20 inches per annum and even lands with rainfall up to 28 inches will have precarious agriculture. Judged from this statement, 36 per cent of Australia with less than 10 inches of annual total, have no chance of agriculture. Lands with a total rain above 20 inches amounts to 32 per cent, of which a considerable portion would be mountains and water-divide. Since areas with rainfall above 20 inches are all situated along the coast, the congestion of population in the same zone is easy to understand.

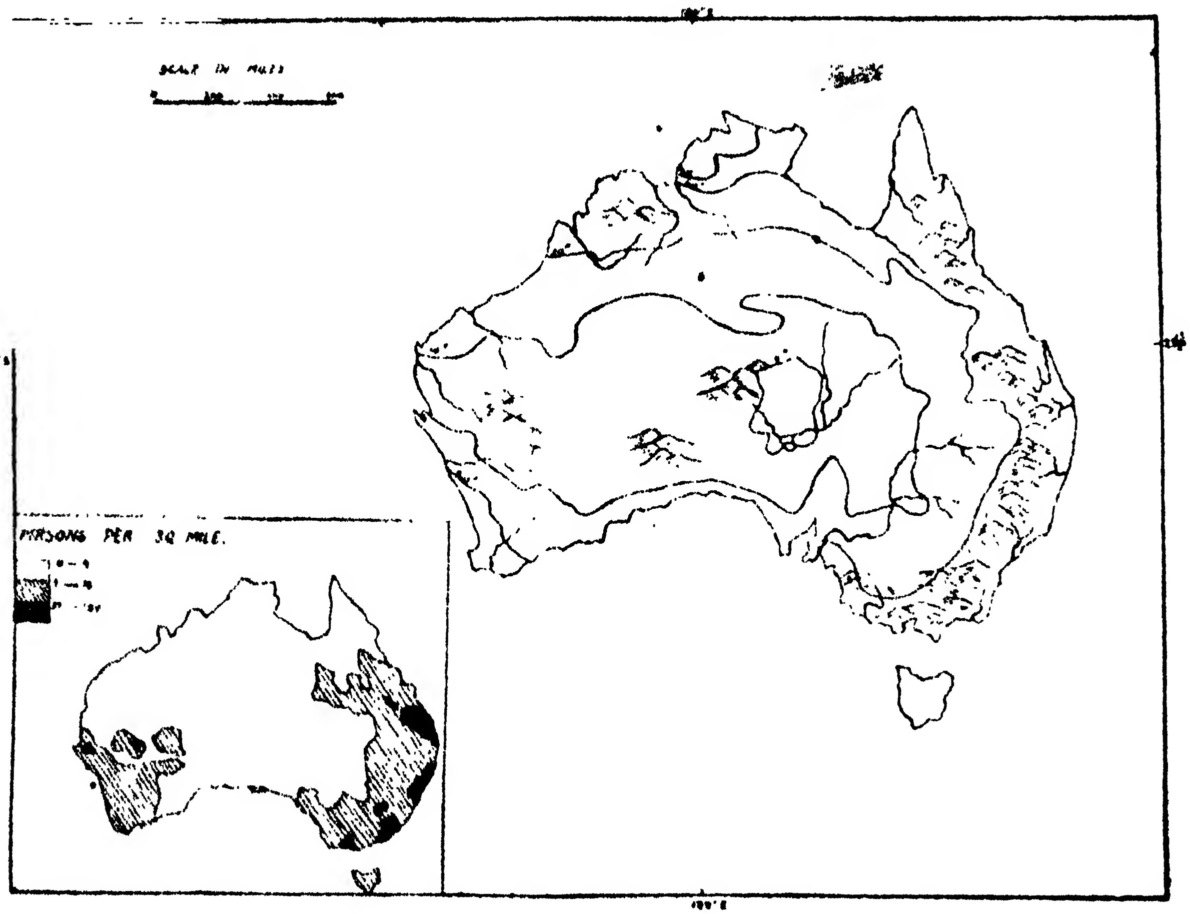


FIG. 1

But why should the rain be distributed in the manner indicated above? This is because of the geography and the geomorphic build of the continent. Australia has aptly been described as situated in a 'meteorological no-man's land'. Placed roughly between 10° and 40° south latitudes, the tropic of Capricorn almost bisects the continent. The northern fringe is under the South-East Trades whereas the Westerlies skirt the southern edge. The coastal girdle of eastern ranges, rising up to 5000′, shut out all access of rain-bearing winds even when depressions are created in the centre when Australia has her summer (our winter). The central ranges rising up to 4000′ only are nowhere high enough to act in the same way as the Himalayas in India or the Alps in Europe. Thus when the northern coastal belt and the south-east, register annual falls of 30″ to 40″ the major portion of the central and western Australia receive less than 10″ only.

Even the little rain that falls cannot be stored by Nature in the subterranean reservoirs. The geological structure of the country is a serious impediment in this regard. Australia's physiography reveals three distinct structures. Major portion of Western Australia is a peneplaned plateau covered by preCambrian rocks, with occasional spreads of Palaeozoic strata, the whole uplifted in the Pleistocene age. The entire area excepting the Peruvian basin in the north-west adjoining Derby is unsuited for subsoil storage. The eastern coastal chain of folded mountains is a sedimentary series of primary and secondary rocks uplifted in the Pleistocene contemporaneous with the uplift of the western peneplain. In between these two, is con-

tained the geosyncline comprising rocks of the secondary and tertiary era. It is these porous sedimentaries resting on impervious metamorphics which are 'par excellence' the depositories of the percolated rains. Being lower than the uplifted areas on both sides, the run-off from the adjoining country gravitates towards the centre, mostly in the Lake Eyre and Murray basins where along with water also collect all the soil-wash. A thick pile of soils have therefore accumulated in this way similar to that in the Indo-Gangetic trough. The low peneplaned western block, the subdued eastern mountains and the almost filled up trough all combined, have robbed Australia of a variety in relief and climatic conditions so essential to a multiple economic activity. The climatic belts in Australia are determined mostly by the extensions in terms of latitude.

With such unfavourable conditions, and consequent slender resources, it is no wonder that Australia should be keen in conserving every drop of her rain water. In fact, much of the success of her target to build for 20 million inhabitants instead of the present 7 millions depends entirely on this. But how is it to be achieved? Most of the rain that falls on the ground flows away as so many rivers to the sea. It is therefore by conserving water in the river basins that the water supply for the continent can be increased. A look at the drainage map of Australia is expected to give us some idea of the possibilities of conservation. Australia is provided with two types of rivers. The perennial rivers are mostly to be found along the coasts where they rise in the coastal ranges and swiftly flowing along the slopes of the hills discharge into the sea. These rivers are mostly torrential in nature and dissipate large amounts of water and energy, all untapped. Some rivers like the Murray-Darling or those draining into the Lake Eyre are widely fluctuating streams, bringing down comparatively larger run-offs during the monsoon months and running dry in the summer just as the Damodar does in Bengal. These rivers however flow over potentially rich agricultural lands and therefore offer the best possible scope for development. A large portion of Australia, mostly that included within 10″ isohyet, *i.e.*, the peneplain and a part of the geosyncline, is characterised by scars comparable to the 'wah' in Indian desert, through which water comes down in periods of four or five years. These offer no scope for surface storage. This makes it all the more imperative that water elsewhere should be conserved to the last drop. J. D. Lang's* estimates of water resources point to the fact that even if all the resources are developed they are unlikely to irrigate even 25% of Australia's irrigable lands. It is no wonder therefore that the two States of New South Wales and Victoria have already spent £50,000,000 on developments and many more costly undertakings are in hand.

Of the rivers of Australia, in the Central Basin, two systems are worth mentioning. One is the Lake Eyre Basin, where the rivers Finke, Diamantina or Cooper's Creek bring down the run-off from the western slopes of the coastal range in Queensland. But the contribution from these rivers being scanty and occasional, there cannot be any big project of conservation in the basin. Two very bold schemes have however been suggested to convert the 610,000 sq. miles of tract in the Eyre basin into rich agricultural fields. 'The scheme suggested by Bradfield provided for conservation of the waters of several of the east coast rivers and the conveyance of water so conserved to the west of the divide, there to be distributed on the central plains as irrigation water and domestic and stock supplies. The yield of the inland flowing streams was also to be conserved for the same purposes. The scheme suggested by Idriess was basically the same as Bradfield's, except that he suggested tapping all the east coast and gulf rivers—if necessary, pumping and piping the lot.'

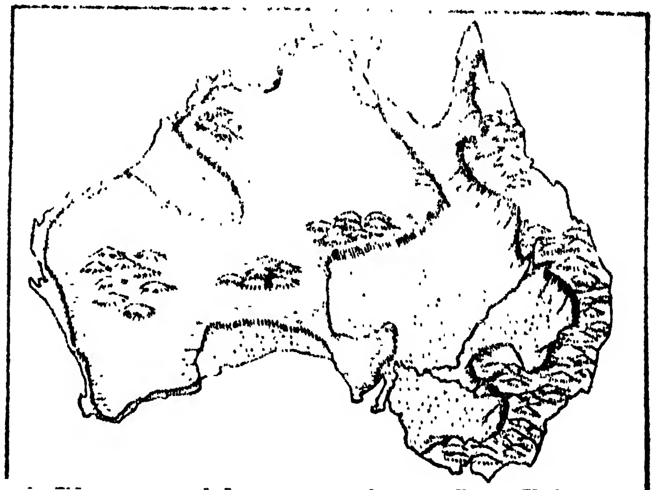


FIG. 2

But how much water can actually be utilised in this way? J. D. Lang's probable estimate of total water resources of Queensland rivers would not exceed 18½ million acre feet almost identical with the total water percipitated in the Damodar basin. If 75 per cent of this average flow is harnessed and allowance is made for evaporation amounting to one-million acre ft. per year (in the light of experience in Victoria) a regulated yield of 13 million acre ft. could be obtained. As in Victoria, if a distribution efficiency of 30 per cent is accepted as the standard

* Australian Water Resources, J. D. Lang, *Water and Water Engineering*, November, 1946.

(considering the temperature and porosity of the soil), not more than 4 million acre ft. would be normally available for the land. The benefits of irrigation may then be extended to as much as 12 million acres of land depending on the type of crop. This can support a population of about 3 million only.

The Murray has been called the 'Nile of Australia'. The basin of the Murray comprises an area of 414,000 sq. miles of which the catchment areas along the interior slopes of the mountains in the S. E. of Australia (Victoria and Queensland) would amount to 158,500 sq. miles. With an average annual rainfall of 17″ the total precipitation in the basin would amount to about 150 million acre ft. per annum. The Murray and the Nile play the same parts in the economic life of the respective continents. As a matter of fact, the Nile basin (1,160,000 sq. mile) is more than 2½ times the area of the Murray basin (414,000 sq. miles), with three times the average rainfall. 'The Nile is 2½ times as long, and its mean annual discharge (79 million acre ft.) is more than seven times as great as that of the Murray (10 million acre ft).' The developments in the Murray valley comprising as it does of four autonomous States each fiercely cognisant of its rights, the most important from the point of view of the country's economy, have been rather complex and unco-ordinated. We reproduce in a bit of details the existing conditions and problems.[3]

"By far the most important complex of irrigation work in Australia is in the Murray Valley Basin . . . . There is a complex of irrigation areas (intensive cultivation), irrigation districts (extensive cultivation), and irrigation trusts, domestic and stock water supply districts, and bore trust districts. These are under the independent jurisdiction of three States, with the First Mildura Trust in control in the Mildura district The works are based on the waters of the Murray and its Victoria tributaries such as the Goulburn, the Loddon, the Campaspe; on the Murrubidgee and the Lachlan rivers with one fairly extensive water trust near its confluence with the Murray, and numerous bore trust districts along the upper reaches of the Darling all in New South Wales . . ."

"Although these various systems are under four separate and distinct controls, they are in fact all geographically part of the one system, and are tending to become interlocking. This points to one of Australia's irrigation problems, multiplicity of controls and an element of jealousy and parochialism as between the States. The three States concerned could have co-operated with one another to a greater extent in the interests of national welfare."

"In Australia as in many other countries, political borders have been laid down arbitrarily, and often run counter to true geographical boundaries. There is an argument in favour of forming a Murray Valley States, to which could be entrusted the co-ordinated development of the valley."

What a strange similarity things in India have with the conditions in Australia? We have often pleaded and repeat the argument once more of setting up administrative units based on economic and geographic considerations. The Government of India has, of course, accepted the idea of creating a 'Damodar Valley Administration' ignoring such artificial boundaries as between Bengal and Bihar and the sooner it is legislated the speedier would be the task of expediting the development. Similar autonomous units for other rivers like the Mahanadi, the Tista, the Kosi, etc., should also be set up which would look to the balanced development of the entire valleys in all its phases The 'Barbarism of Borderism' which is however not peculiar to Australia alone is very nicely illustrated for that country by a particular river, the Snowy river which flows through the States of New South Wales and Victoria. The fight over the use of the water in this river has been waged for years resulting in the loss of 1,000,000 gallons of water per hour or nearly 100 cusecs of easily available water which runs to waste.

Development of water resources in Australia does not end with the rivers alone The aquifers entombed in the geosynclines are also being successfully bored in the Murray basin, the Great basin (spread over Queensland, Southern Australia and Northern Territory), the Eucla basin (Western and Southern Australia) and the Deserts basin (adjoining Derby) and the North West basin In certain cases water is piped to long distances for supply in mining towns.

The Australians are proceeding with bold vision to outbid the past. 'Thoughtful Australians have advocated a national federal authority to control and conserve all catchment areas (on which the streams depend for their vitality and perpetuity). It is likely that a national soil conservation authority will soon be established'. They have already profited through development projects. The Murray basin for example where 4 million acre ft. of water of melting snow used to run to waste and the country was given to sheep and cattle, the irrigation areas now support 20,000 people in a district as against 700 prior to irrigation.

As regards tangible results, "to date a total of about £22,000,000 has been spent on irrigation in New South Wales, including about £19,000,000 by

[3] Edgar Bee, Water is Life in Australia. *Water and Water Engineering*, Nov., 1946.

the water conservation and irrigation commission, and approximately £25,000,000 in Victoria. Annual value of products from irrigation areas in New South Wales is approximately £3,000,000 representing a return on the national investment of about 12½ per cent. The Wyangalla Dam, on the Lachlan river, paid for itself in one year of drought. In 1944, it saved more than 1,000,000 sheep from death by thirst and starvation."

Edgar Bee continues "Summing up we may conclude that water conservation and irrigation works despite some hardships, disappointments, unforeseen heavy expenditure, and positive wastage far exceed in national benefit the money spent."

POLYSTYRENE

A MIRACLE MATERIAL FOR INJECTION MOULDERS

M. A. AZAM

STARTING its commercial life in 1939 Polystyrene has made great strides during the last few years and has revolutionized thermoplastic moulding. Polystyrene is the lightest of commercial plastics. It is cheaper than any other thermoplastic, unaffected by water, alkalis, alcohols and most acids. Moreover, it has exceptional dimensional stability and is available in a wide range of colours—from sparkling transparent through delicate pastels to rich opaques. The pre-war users of "Trolitul" which is the German trade name of Polystyrene will readily appreciate the opportunity of getting supplies of their old favourite once again. Moulders who have been using cellulose acetate for manufacture of combs, soap boxes etc., may safely and promptly switch over to this ideal material with considerable advantage.

One of the first applications of Polystyrene was in closures for acid bottles. It has since found many other applications some of which may be listed as follows: combs, cosmetic, packages, calling cards and cigarette cases, battery cases, etc.

The ability of Polystyrene to carry light around curves or through flat surfaces makes it particularly appealing in certain applications. When the edges of an instrument panel moulded of Polystyrene are exposed to a concealed light it glows forth at each marking. In a similar way, a ring of moulded Polystyrene mounted around the face of an aircraft instrument dial and lighted from the rear makes the dial fully illuminated with a soft pleasing glow from the ring and totally cuts off any unpleasant glare to the pilot.

Initial brightness and afterglow of "luminescent" Polystyrene depends upon intensity and time of excitation and also size and shape of moulded articles.

Polystyrene, standard or luminescent can be moulded in any injection type machine in which acetate has been used. It does not require any special mechanism or precaution handling. As usual, the moulding machine is first adjusted by trial to the correct temperature, pressure and curing cycle.

Polystyrene is vastly superior in many respects to cellulose acetate which it may substantially replace in injection moulding for no other reasons than the most sensible ones of quality and economy. "Technical Data on Plastics" published by the Plastics Materials Manufacturers' Association, Washington, D.C., lists the following outstanding characteristics of Polystyrene:

1. Exceptionally good electrical properties, which remain practically constant over a wide range of frequencies, temperatures and humidities. These properties are not impaired appreciably even after long immersion in water. The material has excellent arc resistance and is non-tracking.

2. Excellent resistance to corrosive chemicals, such as acids, alkalis and salts, to lower alcohols, and to aliphatic hydrocarbons. Water absorption is negligible even after long immersion.

3. Excellent dimensional stability which is important where close tolerances are required.

4. Brilliant clarity. By proper compounding any desired colour can be obtained. The material possesses the ability to "pipe" light, even around corners, because of internal reflection.

5. Low unit weight. It is one of the lightest plastics at present commercially available.

6. Stability at low temperatures. It is tough and stable at subnormal temperatures as it is under normal atmospheric condition, and does not become weak or brittle even when chilled to stratospheric temperatures.

7. Freedom from taste and odour.

8. Excellent mouldability.

The resistance of Polystyrene to water is phenomenal—the water absorption in 24 hours being 0·00 to 0·05 per cent only while in the case of Cellulose

acetate it may be as high as 4.5 per cent. Besides, cellulose acetate is slightly soluble in water (0.1—1.3 per cent in 24 hours).

The low water absorption facilitates storage. The moulding characteristics do not vary with changing humidity. Mould cycles can therefore be accurately set and uniformity in moulded pieces better ensured. The advantages are further augmented by the fact that Polystyrene has lower mould shrinkage so that the moulded articles closely follow the dimensions of the mould cavity. The material has a higher heat distortion and it does not become brittle at lower temperatures. Thus, Polystyrene is particularly suitable for use under varying and extreme climatic conditions of India.

The flow of a thermoplastic material like cellulose acetate is controlled by the nature and proportion of plasticizers used in the formulations of the compound. Besides acetone, cellulose acetate moulding powder usually contains triphenyl phosphate, tricresyl phosphate and methyl phthalyl ethyl glycollate. These chemicals naturally influence the processing of articles, their storage, transport and stability. No plasticizer is, however, used in the compounding of polystyrene, the various flow grades are accomplished through control of molecular weight and molecular distribution which, in turn, are factors of the degree of polymerization. Plasticizers are occasionally a source of difficulty in using certain material and cause shrinkage. Most plasticizers affect the resistance to many different types of packaged products. Some plasticizers have undesirable effect on metal inserts.

Comparing the specific gravity of cellulose acetate (1.32 average) with that of Polystyrene (1.06) it will be evident that Polystyrene will give about 17-25 per cent more pieces for a given quantity of the material. The price of Polystyrene is also cheaper and it exhibits practically no breakdown during the process of injection moulding so that all scrap in the form of runner and sprues can be pre-used after grinding. These factors work out a saving of 30—40 per cent in the cost of the moulded products.

In Germany, Polystyrene was more extensively used than in U. S. A. or in the United Kingdom. Injection moulding requirements in Germany during the war used three-quarters of Polystyrene production. The remainder was used in coatings and in the manufacture of sheets. In 1943 the U. S. production of Polystyrene was 4,000,000 lbs. only whereas German production in that year was more than four times as much (16,400,000 lbs). In 1945, the U. S. production was estimated at 15,000,000 lbs. Polystyrene was commercially introduced as material for injection moulding in 1938-39. Since then the advantages of this material have been more and more appreciated. In India a couple of injection moulders started to manufacture combs using Polystyrene under the trade name "Trolitul". These were used in 2 oz Isoma machines and run at 210°C. The curing time was about 9 seconds. The pre-war users of Trolitul need not be told about the advantages of using Polystyrene. They must have remembered how smooth was the working of the machine with Polystyrene, how quickly the pieces set and came out 'bone dry' from the mould cavities identifying themselves with their characteristic and pleasing metallic sound. There was no pungent acetic fumes which sometimes trouble the operator while working with acetate.

With the outbreak of hostilities Polystyrene, like many other chemicals, went to war. It was available only for essential military applications. Styrene, the monometric form of Polystyrene played a very important part in the manufacture of synthetic rubber. It was, however, long predicted that in the post-war period Polystyrene would be an ideal, abundant and inexpensive thermoplastic. The prophecy has come true.

Notes and News

ATOMIC ENERGY RESEARCH

At the first meeting of the Board of Research on Atomic Energy (see SCIENCE AND CULTURE, September, 1947) held under the chairmanship of Dr H. J. Bhabha, the question of the training of persons for nuclear research was discussed and decided to draw up a scheme for basic education in nuclear research in Bachelor of Science (Honours) and Master of Science in the Indian Universities.

The Board stressed the need of Indian Universities being encouraged to give the minimum basic training in the theory and technique of atomic research.

The biological aspect of the nuclear research was also discussed by the Atomic Research Board and it was decided to recommend to the Dominion Government that a highly qualified expert who is now available in India should be sponsored to do physiological research in cancer in connection with the Radio Active appliances jointly at the Tata Fundamental Research Institute and the Tata Memorial Hospital for cancer.

The Board also recommended a scheme for theoretical research in cosmic rays in the Delhi University.

NEW AID TO SEARCH FOR RADIOACTIVE MINERALS

A MODIFIED form of "Geiger Counter" is being employed in search for uranium ores. These instruments are portable and by means of earphones 'ticks' can be heard which tell one that some alpha-, beta-, gamma-ray particles produced by disintigration of radioactive elements has entered the ionization chamber of the instrument. By finding the frequency of such ticks an indication may be obtained of the presence of extraneous radioactive bodies. The instrument has also been employed in oil-wells to map underground structures.

This instrument may be of great help in India in the systematic search for the radioactive minerals that is going to be carried out by the G.S.I. for the Atomic Research Committee set up by the Government of India. (*Scientific American*, February, 1947).

NEW ISOTOPE OF CARBON

RADIOACTIVE carbon with an atomic weight of 14 as compared with 12 for ordinary carbon was one of the physicists' many predictions. There was a theoretical suggestion that if a Cosmic Ray neutron should strike a nitrogen atom in a certain way it would convert it into an atom of radioactive carbon. The formation C^{14} by the neutrons produced by the cosmic radiation had been forecast by Dr Libly of the Institute of Nuclear Studies of the University of Chicago. Recently the existence of C^{14} in methane derived from sewage is reported (*Science*, *105*, 576, 1947). The work is an example of perfect team work of six men between the above research institute and a manufacturing firm, Houdy Process Company of Philadelphia. The work of separating the isotope of carbon from the methane was carried out at the Houdy plant and the radiation measurements were made at the University of Chicago. Methane prepared from petroleum was found to contain none of the C^{14}. The reason is C^{14} has a half life of 5,000 years and petroleum is much too old composition to contain this active form. The above note has been adapted from reports in other journals and lacks certain details. We are awaiting the particular issue of *Science* for further details.

THE DIXENCE DAM, SWITZERLAND

A REMARKABLE feat of engineering has been recently revealed by Professor A. Stucky in describing the great Dixence Dam in Western Switzerland. According to this author, who acted as chief consulting engineer of this project, the dam was completed before the war but the details of its design and constructional features could only be revealed now.

The purpose of this dam is to form a storage reservoir of 1800 million cubic feet, in the upper valley of the Dix, the top of the dam being at a height of 7300 feet above the sea level datum. The crest line forms an arch of 1500 ft. length across the valley, composed of part-circles with a radius varying from 460 feet to 1480 feet, and leading over to a straight-lined overflow weir on the right bank. The most outstanding feature of this dam is the fact that it consists, not of a massive structure, but of a series of large H-shaped concrete pillars, the "flanges" of which form continuous upstream and downstream faces, whilst the length of the "web" varies from 180 feet at the bottom to 28 feet just under the top which is formed by a massive crest. There are thus inside the structure, between the webs of the H-

shaped pillars, large hollow vertical cells, which have resulted in a great saving of material, compared with a massive dam, and which incidentally make it possible to observe the reaction of the structure under the influence of various pressure and temperatures. There are some 31 pillars from 40 to 45 feet apart, the heighest measuring 280 feet and consisting of "plastic concrete", coupled in pairs with expansion joints in between. Because of the latter, it was not possible to take into account any vault like effect of the arched shape dam, and each pair of pillars had to be proportioned and designed without regard to any support from its neighbour. The straight-lined and almost vertical upstream face transmits the water pressure into the pillars while the concave downstream face protects the main structure from the influence of snow and frost. Both the faces of the dam are laid out with masonry composed of special frost proof stone material found in Switzerland. The construction of the dam was proceeded through systematic geological investigations of the ground by means of test galleries which were later used for the diversion of the river during the time of construction. The dam required an excavation of 0 million cft, while it contains 11 million cft. of concrete and nearly 1½ cft. of masonry (*Bulletin Technique de la Suisse Romande, No. 4, 1946*).

S. K. G.

HOURLY AND DIURNAL VARIATION OF RAINFALL AT BANGALORE, POONA, SIMLA AND MAHABALESHWAR

Distribution of rainfall in the different hours of the day is of interest from various points of view. A knowledge as to the time of the day when there is a tendency for the most frequent occurrence of rainfall and for the maximum amount of rain to occur will doubtless be of value to engineers, contractors engaged in constructional work, tourists and holiday-makers, not to mention others.

In a paper, entitled "A discussion of hourly rainfall and associated wind direction at Bangalore" (India Meteorological Department, *Scientific Notes, Vol. 9, No. 102*), the hourly rainfall records of the Bangalore Observatory based on data for the years 1895-1934 are analyzed. Precipitation is most frequent and heavy during the evenings and the early part of nights during all the seasons. Forenoons get generally the least amount of rain. Thus convection is the chief cause of rainfall over Bangalore. Most of the rainfall measured at Bangalore is associated with westerly winds and the least amount of rain occurs during calm weather. As in the case of other Indian stations winds from the least frequent directions have the greatest association with rain.

In another paper "An analysis of the hourly rainfall records at Poona" (*No. 103*) the hourly rainfall at that station during the years 1930-1939 has been analyzed, and the frequency distribution of different amounts, the diurnal variation of rainfall and the distribution of rainfall with surface and upper winds from different directions studied. The characteristic feature of the diurnal variation is a marked increase in the afternoon hours of both the rainfall amounts and occasions of rainfall in all the months except July and August, when the monsoon is strong. Rainfall is found to be most frequent in the cold weather with winds from N-E, with winds from S-E to S in March and April, with winds from W to S-W from May to September, and with winds from N-E to E as along from S-W to W during the retreating monsoon.

In the *Scientific Note, No. 104*, the records of a self-recording raingauge at Simla are analyzed for the years 1919-1926. The data during the winter months are vitiated by the absence of a heating arrangement to melt the snow as it fell. During the rest of the year there is generally a tendency to a maximum in the afternoon and a minimum in the early part of the night.

In *Scientific Note, No. 105*, the hourly rainfall records of Mahabaleshwar for the years 1931-1940 have been analyzed. The data are too few to give a clear inference for the winter months. During the rest of the year, the situation of the station on the Western Ghats, which favours the development of convection in the afternoon, seems to be the chief factor in affecting the diurnal variation.

METAL CASTING FINDS A COMPETITOR IN POWDER METALLURGY

Powder metallurgy is by no means a new subject, but in recent years such progress has been made in this branch that powder metallurgy has passed into the realm of exact science. The process consists fundamentally of moulding a metal powder to any desired shape by the application of pressure. Recently, heat and moulding pressure have been applied simultaneously to the powder and this technique is called 'hot pressing" or 'sintering'. The effect of pressure and heat causes increased atomic mobility within the individual power particles. As soon as the atoms acquire sufficient momentum to overcome surface tension and other physical obstacles diffusion of adjacent particles takes place and bonding occurs. The technique of powder metallurgy is not confined only to powders of single metal, alloys can also be produced in this way. An intimate mixture of individual powder required in the alloy is pressed and moulded to the desired shape. After

suitable heat treatment or sintering a solid compact of the alloy will be produced. The material will often be more homogeneous than the equivalent cast alloy. Mixtures of mutually insoluble or partly soluble metals or mixtures of metallic with non-metallic powders can be sintered, resulting in novel products which cannot be obtained by other means. The commercial fabrication of the refractory metals, such as platinum, tungsten, molybdenum, tantalum and titanium was made possible by powder metallurgy. New materials like hard carbide tool lips, wire drawing dies, etc., and complex materials such as tungsten-copper for electric make and break contacts and copper lead bearing metal, cannot be manufactured at all or not so well by other methods than powder metallurgy. The newly developed magnetic material of higher magnetic energy than older alloys, the complex iron-nickel-aluminium-cobalt-copper alloys universally known as Alnico and Alcomax are very hard and brittle and can be shaped only by grinding and it is very difficult to make Alnico and Alcomax casting with accurately located holes and bores.

Thus the new alloys, though by far the most powerful permanent magnets, could not be commercially employed because of their fabricating difficulties. Recently a process has been developed by which sintered permanent magnets can be made of Alnico from metal powders.

P. C. D. G.

SUBMARINES OF THE FUTURE

NAVAL warfare with submarines is not yet discontinued by the atomic bomb. From lessons learnt at the Bikini tests, plans have been made by U. S. Navy for underwater craft that will enable their equipment to withstand even the explosions of atomic bomb in water. German blue-prints for U-boat development have been secured by U. S. Navy staff and they are considering the developments. These were made to stand against the anti-submarine measures adopted by the Allies. The submarines are now detected under water by sono-radio-buoy. It is a small floating device dropped in the suspected area from an aircraft. The buoy contains submerged hydrophone capable of picking up the underwater sound made by submarine propellers. The hydrophone triggers a tiny radio transmitter in the buoy that sends coded signals to the plane above. After detection, the actual 'kill' is by shell fire in case of visual detection or by depth charges. The submarines as they are, are still chained to contact above the water for air either by surfacing or the use of long breathing tubes. It may be noted the major bulk of research grants in the United States at the present moment are being financed by the Army and the Navy. The German submarine accessories and new craft, it appears, if available earlier, might have prolonged the war. The 'Snorkel' system is an important development. It has a breathing tube that can be used when the submarine is relatively near the surface but still hidden under the water. Vessels with snorkel need not come entirely to the surface to recharge power batteries. In fact, many remained submerged for period of 70 days. Another development is streamlined hull with increased battery capacity and consequential higher speed. Increased speed, though secured for limited period make it easy to escape detection and destruction. There were plans also for hydrogen peroxide gas turbine engines making for a speed of 24 knots, at least for period when spurts were needed. This speed far exceeds the best underwater crafts even when on the surface.

DEVELOPMENT OF SOUTH PACIFIC ZONE

A COMMISSION has been established with temporary headquarters at Sydney under joint undertaking by the Australian and New Zealand Governments with the object of promoting international co-operation in the development of economic and social welfare of the people of the non-self-governing territories in the South Pacific region. The participating countries have each territories in the area and they are Australia, France, Netherlands, New Zealand, United Kingdom and the United States. An initial budget of £40,000 has been provided with Australia carrying almost one-third of the amount. The commission's function will be advisory and it will organize studies and recommend measures in matters of agriculture, fishery, transportation, industry and labour, marketing, etc. The commission will however finance public works, education, health and social welfare schemes. Each country will appoint two commissioners, who will jointly hold at least two regular sessions per year. An important unit of the commission is a standing research council manned by full time personnel. The commission has been sponsored independently of U.N.O. and the zone of activities is naturally outside the present political set-up.

INFLUENZA VIRUS

Influenza virus consists of protein, nucleic acids, lipide, carbohydrate, 60 per cent water and an antigenic structure characteristic of the host from which the virus is obtained. The virus has not yet been obtained in crystalline form, but the particles of the virus are large spherical structures about 10m μ in

diameter. Two strains of the virus representing type A and type B have been investigated by Dr Stanley at the Rockefeller Institute for Medical Research and he gave a review of the work in a recent lecture at Philadelphia. He received the Nobel Prize in Chemistry in 1946 jointly with Drs Northrop and Sumner. The two strains do not produce immunity against each other and five definite differences in amino acid composition were found between them. These studies indicated that there were chemical changes with the change in virus characteristics. The results of the studies give further evidence of direct dependence of biological activity upon chemical structure.

The influenza epidemic of 1918 ranks third in the destruction of human lives after the two epidemics of plague caused by *Bacillus pestis* in the 6th century and 1350 A.D. It has been estimated that of 500 million people attacked, 15 million died. Dr Stanley is optimistic that the highly purified influenza vaccine developed during the last war should produce a means of preventing such a human catastrophe. The Rockefeller Institute is a privately endowed body but their team spirit and research activities have laid well the basis for international co-operation.

PROTOZOAL DISEASES AND DOMESTICATED ANIMALS

"The role of Arthropoda in the transmission of Protozoal Diseases to the domesticated animals in India" was the subject of an address, recently delivered by Dr H. N. Ray, Protozoologist, Indian Veterinary Research Institute, Mukteswar (Kumaun), to the Zoological Society of Bengal. Dr Ray dealt at length with the important diseases such as surra, babesiasis and theileriasis. The causal agent of surra, known as *Trypanosoma evansi*, was stated to be transmitted mechanically from an infected to the healthy animal through the agency of biting flies, chiefly the tabanids. The buffaloes and cattle served as 'carriers' and hardly evinced any sign of the disease. Dr Ray's researches showed that in nature these carrier animals played a great part in perpetuation of surra in this country. Control measures should be directed towards (*a*) the treatment of clinically affected cases with the specific drug 'Antrypol', (*b*) adoption of diagnostic methods such as complement fixation test or allergic test for the detection of latent carriers, (*c*) treatment of the positive reactors to the above tests and (*d*) adoption of fly control measures which would include both the destruction of tabanid eggs and liberal use of fly repellent during the fly season. A prophylactic dose of Antrypol (5 grms. per 100 lbs. body weight in a 10 per cent solution in sterile distilled water) had a commendable effect in saving equines from getting attacks of surra in an endemic area. The dose had to be repeated at the end of every third or fourth week throughout the fly season.

Babesiasis in animals was transmitted by ticks, such as *Boophilus australis* and *Rhipicephalus sanguineus* and also perhaps by such other ticks as *Hyalomma aegyptium, Haemophysalis bispinosa* and *Ornithodoxes savigni*. The organisms causing babesiasis are known to pass through the eggs of tick and hence the progeny of an infected tick are also infected. A peculiar feature of this protozoal disease is that not only the vertebrate host help in the perpetuation of the disease by becoming carriers but the intermediate host (the tick) also plays an important part by passing the infection to the progeny through the medium of eggs. Any control or eradication measure should be directed firstly towards treating the clinically affected cases with Acaprin or Phemanidine and secondly, applying measures for the destruction of ticks such as DDT sprays and use of arsenical tick-dips.

Theileriasis produced by *Theilaria annulata* is known to occur in some parts of this country and is said to be responsible for a fair amount of mortality amongst calves. The tick responsible for the transmission of this disease is *Hyalomma aegyptium* and according to Dr Ray, unlike the observations of some foreign workers on allied species (*T. parva*) this organism (*T. annulata*) could pass through the eggs of *Hyalomma aegyptium* and thus the progeny of infected ticks were also infected. It was observed that the transmission of the disease could only be affected in the adult stage and not in the larval or nymphal stage of the tick. Since no chemotherapeutic agent was yet known to cure theilariasis the adoption of tick control measures was very strongly recommended.

Concluding, Dr Ray referred to various lacunae in our knowledge about the life-histories of protozoa in Arthropods and as well as in the vertebrate hosts. He stressed that the students of Zoology in the various Indian universities should be guided along these channels and thereby help to bring the science of parasitology to a perfection for the well being of our domesticated cattle.

ELECTRONIC MEASURING IN HORTICULTURE

Both for agriculture and for the horticulture, soil-testing is of great importance. The work on the analysis of soils leads to the improvement of the soil for the growth of the crops. In recent years the interest in this direction grew to such extent that the laboratories have been opened in many countries for soil analysis.

The cause of the failures in hothouse cultivation has in many cases been traced to too high salinity of the soil, and a general examination of the soil in the Aalsmeer hothouses showed that in 60 per cent of the cases the soil was too salty. The chemical analysis of the soil is cumbersome and takes a great deal of time especially when a large number of samples have to be tested regularly.

Nowadays the salinity of soil solution is determined by measuring the electrical conductivity of the solution. The greater the salinity of the extract the greater is its conductivity. The sample drilled from the soil is first dried, ground, and sifted and then shaken in distilled water in a beaker. A Phillips immersion cell, type GM4221 with a thermometer is placed in the beaker and the resistance of the liquid column between the charged electrodes of the immersion cell is measured with the aid of the Phillips universal measuring bridge 'the Philoscop' GM4140. The inverted value of this resistance multiplied by the constant of the cell gives the conductivity of the liquid. It is necessary to control the temperature carefully because this has a considerable effect upon conductivity.

Normally the bridge proper (the part forming a Wheatstone bridge) is charged from the philoscop; the power supplied by this is of such low frequency that in liquid measurements polarization and discharge phenomena are apt to occur, and for that reason it is preferred to take the liquid measurements with a current of higher frequency by using the Phillips oscillator GM4260 which gives a voltage of 2 V at a frequency of 100 c/s. thus producing any possibility of polarization in the liquid being measured. The bridge part is disconnected from the transformer and fed *via* the oscillator which is connected to the terminals of the philoscop. The zero-point of the philoscop is adjusted by a cathode-ray indicator.

In the sugar industry the ash content of the sugar solution is determined quickly and accurately by the Phillips Philoscop GM4140 in combination with the 1000 c/s oscillator GM4260 and the immersion cell GM4221. 10 gms. of sugar is weighed off and dissolved in 200 c.c. distilled water, then the electrical resistance and the temperature of the solution are measured, from which the electrical conductivity of the solution is found out. With the aid of Lunden's tables the ash content of the solution is easily determined. The ash content of the sugar solutions can be determined accurately to within 0·05 per cent by this method.

Sturdily built philoscop gives better results than expensive galvanometers which are so sensitive to mechanical shocks. The cathode-ray indicator is inertia less, free from parallex and not susceptible to mechanical shocks and vibrations.

DIRECTOR-GENERAL OF CIVIL AVIATION

Mr N. C. Ghosh, member of the Air Transport Licensing Board, has been appointed Director-General of Civil Aviation in India in succession to Sir Frederick Tymms.

Mr Ghosh served the Indian Railway service for nearly 34 years, and retired from that service in 1946, as General Manager of the East Indian Railway. Mr Ghosh rendered conspicuous services during *Kumbh Melas*, the August 1942 disturbances and recently as the controlling authority for the evacuation of refugees by air.

ANNOUNCEMENTS

Dr Frans Verdoorn, Managing Editor of Chronica Botanica, has been appointed an Honorary Staff Member of the Government Botanic Gardens, Buitenzorg, Java, at the occasion of the 130th Centenary of the Garden, May 18, 1947, in recognition of his work, during the war years, on behalf of the scientific institutions of the Netherlands Indies.

The publication of the *Records of the Indian Museum*, which was suspended in 1942 in view of the urgent need for economy in the use of paper, was revived last year and Part iv of Volume XLIV appeared in December, 1946. It is now hoped to publish, as soon as normal conditions are restored in the country, one part every quarter as hithertofore.

The undermentioned members of the staff of the College of Engineering & Technology, Jadavpur, are engaged in advance scientific and technological studies, in Europe and U.S.A. on scholarships awarded by various sources.

(1) Dr Dilip K. Banerji, Prof. of Organic Chemistry, has joined the University of Wisconsin, U.S.A., as Watumull Foundation fellow and is working in collaboration with Prof. W. S. Johnson on the investigation on the synthesis of Oestrone, the female sex-hormone.

(2) Mr Amiya K. Chatterji, Asst. Prof. of Electrical Engineering is working for Doctorate in Electrical Communication Engineering, under Prof. Everitt at the University of Illinois on a Watumull Foundation scholarship.

(3) Mr Gopal Ch. Sen, Lecturer of Mechanical Engineering is specializing in Machine Tools and Production Engineering under Prof. Boston at the University of Michigan on a G. A. Acharya scholarship.

(4) Mr Mohimohon Mookherji, Instructor of Electrical Engineering, is studying for the degree of M.Sc. in Electrical Communication Engineering at the University of Washington, (Seattle, U.S.A.) on a Government of India scholarship.

(5) Mr Sudhindranath Chaudhuri, Lecturer of Mathematics, is studying for Doctorate in Applied Mathematics and Aerodynamics at the University of Paris (Sorbonne) under Prof. Henri Villat, Member de L'Institut, on a French Government scholarship.

(6) Mr Nalniranjan Mookherji, Instructor of Chemical Engineering is studying for Doctorate in Chemical Engineering under Prof Coulson at the Imperial College of Science and Technology, London, on a Government of Bengal scholarship.

(7) Mr Dilip K. Dutta, Lecturer of Chemical Engineering is joining the Carnegie Institute of Technology, Pittsburg, U.S.A. for M.Sc. degree in Chemical Engineering on a Government of Bengal scholarship.

The British Society of Soil Science was recently inaugurated at London School of Economics on April 15, 1947. The annual subscription for the society is fixed at £1 and the membership is open to all interested in the study and uses of the soil, subject to approval by the Council. The following were elected officers of the Council: *President* C. G. T. Morison; *Secretary* E. W. Russell; *Editor* G. V. Jacks.

Dr J. L. Bhaduri, lecturer in Zoology, Calcutta University and Sir Rash Behary Ghosh Travelling Fellow for the year 1946, has been awarded the degree of doctor of Science of the Edinburgh University. Dr Bhaduri has specialized in the Morphology and Systematic of amphibious and submitted a thesis on the "Anatomy of the urino-genital System of Salientia."

Dr B. Kar, formerly lecturer in Zoology, Bethune College, Calcutta and Sir Rash Behary Ghosh Travelling Fellow of the Calcutta University for the year 1945, has been awarded the Ph.D. degree of the Edinburgh University. While at Edinburgh, Dr Kar worked at the Institute of Animal Genetics, on "Endocrinology of Fowl". Later, he also worked as Resident doctor to the Department of Poultry husbandry, Cornell University (U. S. A.) on "Genetics of Fowl". Dr Kar has been appointed Reader in Zoology and head of the new Department, of Delhi University. He is 28 years of age.

ACKNOWLEDGMENT

We acknowledge with thanks the receipt of the following:

Journals

Science Vol. 105, No. 2739 (June 27, 1947), Vol. 106, No. 2740 (July 4, 1947), No. 2741 (July 11, 1947), No. 2742 (July 18, 1947), No. 2743 (July 25, 1947). *Science & Society* Vol. XI, No. 3 (September, 1947). *The Chemical Age* Vol. LVI, Nos 1458, 1459 Vol. LVII, Nos. 1461, 1462, 1463, 1464. *Water & Water Engineering* Vol. 50, Nos. 616, 617, 618 (June, July, August, 1947). *Agricultural Gazette of New South Wales* Vol. LVII, Part 7 (July, 1947) *Scientific American* July, and August 1947. *Journal of the American Chemical Society* Vol. 69, No. 6 (June, 1947), No 7 (July, 1947). *Journal of Chemical Education* Vol 24, No 5 (May 1947), No 6 (June, 1947), No 7 (July, 1947). *Science News Letters* Vol. 51, Nos 16, 17, 18, 19, 20 and 21 *Discovery* July, 1947 *Sky & Telescope* June, 1947 *Geographical Review* January, 1947. *Science et la Vie* July and August, 1947. *Technology Review* Vol 49, No. 6 (June, 1947) *Endeavour* Vol. VI, No. 22 (April, 1947) *Current Science* Vol. 16, Nos 6 & 7 (June and July, 1947) *Journal of B. S. I. R.* Vol. 6, No 3 (March, 1947).

Books

New Scientific Achievements G. S. Ranshaw. Dynamic Aspects of Biochemistry Ernest Baldwin. Applications of Germicidal and Infrared Energy—Matthew Luckiesh. Mammals of Eastern Asia—G. H. H. Tate. Social Thinking Hyman Levy. Science and Reality T. Bedford Franklin. Hydrostatics—B. N. Prasad From Volga to Ganga—Rahula Samkritayana. Modern Cereal Chemistry—D. W. Kent Jones and A. J. Amos. Alternative Current & Electrical Engineering—Philips Kemp. The Electrician—V. L. N. Row. The Evolution of Modern Physics Carl Trueblood Chase. Theoretical Chemistry—Samuel Glasstone. Radio Activity and Nuclear Physics—James H. Cork. A Hand Book of Rocks—James Furman Kemp. Functions of a Complex Variable—Thomas M. Macrobert. An Introduction to Electro-Chemistry—Samuel Glasstone. Thermodynamics for Chemists—Samuel Glasstone. Cross Roads of Science and Philosophy—Dr Atindranath Bose. The Cathode Ray Tube—S. K. Lewer. Heaviside's Operational Calculus Made Easy—T. H. Turney. Van Nostrand's Scientific Encyclopaedia.

BOOK REVIEWS

The Cavendish Laboratory—By Alexander Wood. Pp. 59. The University Press, Cambridge. £0-2-6.

This book gives a short account of the foundation and growth of the Cavendish Laboratory, Cambridge, which since its foundation in 1874 has taken the lead in the development of physics in England. Dr Alexander Wood, who we believe has been associated with the teaching of Physics in Cambridge since 1908, has given a very interesting account of the history of the Laboratory in this book; a preliminary account appeared in 'Endeavour'.

The first four Cavendish Professors, Maxwell (1871-79), Rayleigh (1879-1884), J. J. Thomson (1884-1919) and Rutherford (1919-37) were outstanding personalities who have left their mark in the development of theoretical and experimental physics. Of these the first three were Wranglers of the Cambridge University, who later took up research in experimental physics, while Rutherford was a born experimentalist with an intuitive insight into the theoretical implications of his experimental work.

If we review the contributions made to Physics by the Cavendish Laboratory since its foundation, we find that it can be roughly divided into three periods. The first begins with the opening of the Cavendish Laboratory in 1874, for which money was provided by the then Chancellor of the University, Duke of Devonshire, and named after his ancestor, Henry Cavendish, the famous eccentric scientist. During this period experiments were undertaken to verify as accurately as possible, some of the fundamental laws of electricity, like the law of inverse square, and Ohm's Law; further accurate determinations were made of electrical standards for resistance and current, and of the ratio of the two systems of electromagnetic units; a quantity which had become of supreme importance in Maxwell's theory. These investigations were continued upto the first period of J. J. Thomson's tenure of professorship. The latter also reproduced some of Hertz's experiments with electromagnetic waves, which provided experimental verification of Maxwell's theory.

Teaching in practical physics was introduced by Maxwell in 1879 and was subsequently systematised and expanded during Lord Rayleigh's time, by Glazebrook and Shaw, authors of the well known text book on practical physics, and later by G. F. C. Searle.

The second period commenced from 1895, with J. J. Thomson's investigations on the ionization phenomena in gases. The starting point of these investigations was the discovery of X-rays by Roentgen, and J. J. Thomson's discovery that these radiations make the gas traversed conductor of electricity. The isolation of electron as common constituent of all material bodies, the measurement of the specific charge on electron, as well as of the charge on the electron, followed in quick succession. This was the epoch of the electrical theory of matter and of the classical theory of the electronic constitution of atoms, of which J. J. Thomson was one of the principal protagonist. Much of these theoretical speculations found brilliant visual verification by the cloud chamber method of photographing the tracks of ionizing particles developed by C. T. R. Wilson. During this period, a large number of colonial, American, and other foreign students were attracted to the Cavendish Laboratory; amongst them were men who made important contributions to physics later, like Rutherford, Langevin, Townsend, Barkla, Max Born, Smoluchowski, Richardson and others. Towards the end of this period, J. J. Thomson started his important investigations on positive rays, and with the assistance of Aston he was able to prove the existence of two isotopes in the rare gas Neon. Later on Aston developed a precision mass spectrograph for accurate measurement of isotope masses. This was the beginning of the epoch of nuclear physics investigations in the Cavendish Laboratory, which later was taken up with great energy and success by Rutherford. The second epoch came virtually to an end with the outbreak of the World War I in 1914, and actually by the resignation of the Cavendish Chair by J. J. Thomson in 1919, after he became the Master of Trinity College, Cambridge in 1918.

Rutherford became Cavendish Professor in March 1919 when he was 48 years of age. He had already made the three major discoveries with which his name will be always associated in the history of Physics *viz.* the detailed exploration of radioactivity and enunciation of the laws of radioactive disintegration, the nuclear structure of the atom, and the first artificial disintegration of a stable atomic nucleus. Rutherford had carried out all his fundamental investigations chiefly with very simple instruments, like the α-ray electroscope, the scintillation microscope. For sources of fast charged particles he used α-particles, emitted by different radioactive elements.

The experimental technique introduced by Lord Kayleigh of employing 'sealing wax, string, rough unplaned wood work and glass tubes joined together by unsightly bulbous, joints', were supplemented in J. J. Thomson's time with a Toepler mercury pump with charcoal and liquid air trap for high vacuum work, a tilted electroscope or a quadrant electrometer for ionization current measurements. The period between World War I and World War II, introduced revolutionary changes in the equipment of the Cavendish Laboratory. Cockroft and Walton were the first to accelerate protons and deuterons by artificial high voltage sources, and thus succeed in disintegrating several light nuclei. Kapitza built up his elaborate arrangement for production of, and measurement in, momentary intense magnetic fields. Later on the Mond low temperature laboratory was erected and placed in charge of Kapitza. In 1935 Lord Austin offered a donation of £250,000 for further construction and endowment of a laboratory for production of high energy particles. Rutherford died suddenly in October 1937, and the scheme of expansion proposed by him could only be completed after the termination of the World War II. Besides a large volume of important investigations on nuclear structure, this period includes the discovery of neutron by Chadwick, and of cosmic ray shower by Blackett; the latter narrowly missed the discovery of the positron.

Maxwell, Rayleigh, and Rutherford were obvious choices for the Cavendish chair, while in selecting the then young J. J. Thomson the electors took a risk, which was later amply justified. There was probably no obvious successor to Rutherford; he had however left a group of promising physicists trained in his school, from whom a successor could have been selected. The electors this time evidently played for safety, by selecting Sir Lawrence Bragg, a former Cavendish man and an able, experienced, if not an outstanding physicist.

With the termination of the war, the Cavendish Laboratory finds itself extensively rebuilt and equipped with powerful and complicated machines like the cyclotron, electrostatic generators of high voltage, Mond low temperature laboratory etc. The tradition established by the last two Cavendish Professors, of a band of young workers led by a great personality exploring unknown territories of natural phenomenon, will probably not continue under present conditions, which requires the co-operative effort of a band of trained scientists to work the large and complicated machines which have become indispensable for present day nuclear research. This tendency has already become evident in many American research establishments. We shall look forward with interest to the future activities of the Cavendish Laboratory.

D. M. B.

Forest Soils and Forest Growth—By S. A. Wide. Illustrated. Published by Walth, Mass., the Chronica Botanica Co.; Calcutta, Macmillan & Co. Ltd.; 1946. Pp. i-xx+1-241. Price $50.00.

THIS book is one of the very few which considers the soil and the forest it supports on it as parts of natural co-ordination and harmony. It is true, as the author says, that "an understanding of the forest lies as much below, as above the ground line."

The present volume encompasses a wide field of forestry. It begins with a historical account of studies of soil and forests, and reiterates the importance of forest in national economy. This is followed by detailed considerations of formation and classification of soil, its physical and chemical properties, the humus and the micro-organisms present in it, and also the inter-dependance of forest vegetation and soil development &c. The concluding chapter of the book deals with such subjects, as survey of forest soil, reforestation and associated problems, management of forests and forest nurseries, use of commercial fertilizers, composts, green manures &c., and even control of parasitic organisms, and the preventive measures adopted for forests and forest nurseries. The book is illustrated by 38 figures, 20 tables and 7 plates, and contains a comprehensive bibliography of about 650 references.

The book had its origin, as the author says, in lecture notes meant for a heterogenous group of students. This has left its mark in making it essentially a text book with rather unconventional treatment of the subject. The illustrations are well-chosen, but some of the photographs look rather inconspicuous by their smallness.

The book is not meant for general readers, although it is well bound and well printed, and is very readable. It will, however, be greatly welcomed by those who are seriously interested in forest and soil.

J. K. C.

Velvet Studies—By C. V. Wedgwood. Pp. 159. Jonathan Cape. Price 7*s*. 6*d*. net.

HISTORY is crowded with great men who tread the high roads of national life, with common people who jostle in the background—a vast undecipherable multitide, and typical men who hover in the byelanes and alleys of the past—significant and symbolical of the peculiar spirit of their country. And if history is, as old Fuller said (who the author quotes), "a velvet study and recreation work", it is so when we can mix with this motley crowd and taste their manifold idiosyncracies. This is what we are enabled

to do in reading Mr Wedgwood's delightfully written pages. He writes fascinatingly of many known and less known personalities, about Straefford who believed in the 'authority of a King' as a 'keystone which closeth up the arch of order and government', and William Pen who abhorred 'obedience upon authority without conviction; about Martin Luther who taught a doctrine which is pure democracy, and Cardinal Richelieu who thought of the State as an instrument towards an end, the mechanism for efficient administration. An alongside of these we are given glimpses into events that the historian is apt to dismiss in a few lines, and reflections that clear up many mysteries. And everywhere lie scattered perpetual felicities of expression that are so illuminating: thus, "When Hampden refused to pay Shipmoney he put up his hand like a policeman at the most dangerous cross-road in our history and firmly diverted the traffic"; about Donne, "He does not, like the later metaphysical poets, soar into the Empyrean, or abandon himself in feminine surrender to the arms of God. The earth is solid under him". But enough of quotations. Mr Wedgwood has written a delightfully informative, engaging and interpretative book, and by relating history to problems of personality on the one hand, and to problems of national character on the other, he has added to the passing show things the unforgettable flavour of permanence.

D. G.

"Juvenile Delinquency and the Law"—By A. E. Jones. Published by Penguin Books, 1945.

THE author had spent a good part of his life in the service of the Law as a clerk in the Magistrate's Court. He had thus ample opportunieties of realising for himself the various problems in connexion with juvenile delinquency. He has pondered over these problems and the book under review is a product of his reflections.

As the title indicates the book deals mainly with the legal aspects of the problems. Students of law will certainly profit by the what seems to us rather academic nature of the discussions regarding the immediate and remote causes and conditions of delinquency, the attitude of the law towards it, the procedures of the juvenile courts as they are and as they ought to be, and the nature of the remedies resorted to at present and in which direction they need to be modified in future. The illustrative cases that have been included will acquaint the readers with the numerous varieties of delinquent behaviours.

The reviewer however is constrained to say that apart from the detailed legal considerations on which he is not competent to make any remarks the book contains nothing either in nature of general statements or special observations which cannot be found in any elementary psychological text book dealing with the problem of delinquency. It may be that the author has not cared to go through any such texts as a deep antipathy towards psychological handling of the problem is only too noticeable throughout the book. Though confessing that "so much about delinquency depends on the reactions of the personalities concerned with one another (p. 31) that "in the last analysis, the only thing which can account for a juvenile delinquency is his own personality" (p 32), that "the essential power of the probation officer is in his personality" (p. 77), he is never tired of making disparaging if not contemptuous references to psychologists and psychiatrists and their endeavours to understand the very nature of that 'personality' and the effects of interactions between different 'personalities'.

"The psychologists are ready with diagnoses, but they do not always agree amongst themselves on the true explanation, and their theories change like fashions in clothes". . . . But at this stage it seems presumptuous to claim that the secrets of the conscious and the unconscious are ours, especially when the much older science of the body has so many discoveries to make". (P. 33). It is not necessary to point out the inaccuracies and the obviously false assumptions in the above argument put forward by one who seems to have been briefed for specially pleading the case of Law against Psychology. Though forced by the logic of his own arguments he is compelled to admit that the aid of the psychiatrist may after all prove helpful and though he goes so far as to recommend that a balanced committee consisting of a psychiatrist, a teacher and an ordinary lay practising parent must needs have a place in any scheme for the treatment of delinquency in future he nevertheless hastens to express his doubts rather positive disbelief about the ability of the psychiatrists to solve the general problem of delinquency and cannot refrain from referring to their "outlandish jargon". Why this ambivanlent attitude?

The author's style is lucid and fascinating and his presentation of the procedures of the juvenile courts of England of the current remedies and of the social factors will be read with profit and interest by all, whether laymen or experts. A little less of the patronising attitude towards psychiatry and a little more of the real scientific outlook might have made the book really useful.

S. C. M.

LETTERS TO THE EDITOR

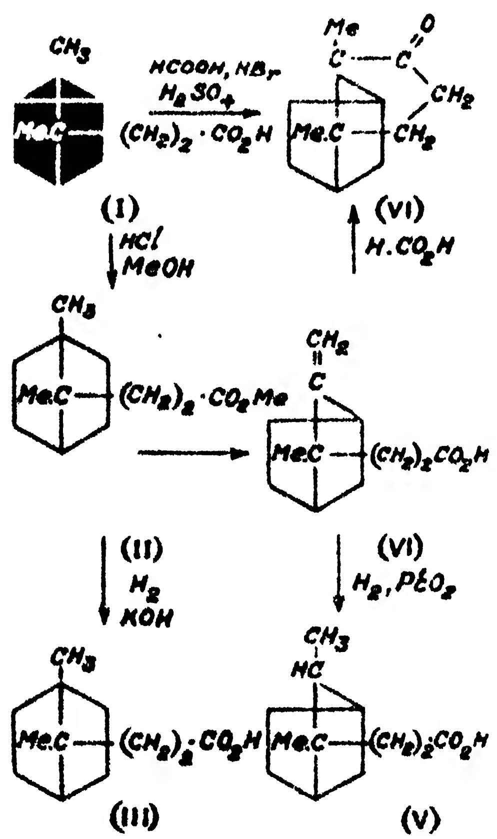
[*The Editors are not responsible for the views expressed in the letters.*]

STUDIES IN THE SANTALOL SERIES

Part VIII: Relation between bicyclo- and tricycloeka-santalic acid

SANDALWOOD oil is known to contain about fifteen chemical substances. From the work of Semmler[1], Ruzicka[2], Simonsen[3], Guha and Bhattacharyya[4] and others it is known that tricycloekasantalic acid, m.p. 76°; $(\alpha)_{5460}$ [illegible] 15·4°, which is obtained by the oxidation of α-santalol possesses the structure (I). The compound (I) on treatment with hydrogen chloride

Part VIII



in methyl alcoholic solution is converted to the hydrochlorobicycloekasantalic acid methyl ester (II), b.p. 145°/5 mm.; α_D -17·8°. Reduction of (II) with sodium and alcohol under mild conditions and subsequent hydrolysis gave (III) along with traces of unsaturated impurities. On removal of the unsaturated impurities with permanganate or ozone, (III) showed the following properties: b.p. 155°/5 mm.; m.p. [illegible], methyl ester b.p. 117°/5 mm.; d_4^{20} = 1·0088; n_D^{20} 1·4809. The compound (II) on hydrolysis with alcoholic potash produces bicycloekasantalic acid (IV), m.p. 64°; $(\alpha)_D$ -41·5° (alcohol), the structure of which has been confirmed by Ruzicka (*loc. cit.* and also part III of this series). The purified compound (IV) on reduction with hydrogen and platinum oxide in methyl alcohol has been found to produce a liquid dihydro-acid (V) not identical with the solid acid (III). This shows that during the formation of (IV) from (II) by elimination of hydrogen chloride a rearrangement has taken place as in the formation of camphene from bornyl chloride. The compound (I) on treatment with sulphuric acid, aqueous or acetic acid solution of hydrobromic acid, gaseous hydrobromic acid in petrol, or anhydrous formic acid, produces a lactone, m.p. [illegible]°, identical with the lactone produced from (IV) by treatment with formic acid. The lactone, therefore, should be represented by (VI). It is, therefore, clear that on treatment of (I) with alcoholic hydrochloric acid, the bond between carbon atom ("2" and "6") is ruptured, whereas with aqueous and acetic acid solution of hydrobromic acid, sulphuric acid or formic acid the bond between 1 : 2 or 1 : 6 carbon atoms is broken. (It will be revealed on close examination that compounds formed by the rupture of the bond between 1 : 2 or 1 : 6 carbon atoms are structurally identical). The case of formation of the lactone (VI) also supports the structure as suggested, otherwise if the bond between carbon atoms 6 : 2 were broken, lactonisation would have involved the formation of a seven membered ring which is improbable.

The author's thanks are due to Prof. P. C. Guha, D.Sc., F.N.I., for his kind interest during the course of this investigation.

S. C. BHATTACHARYYA

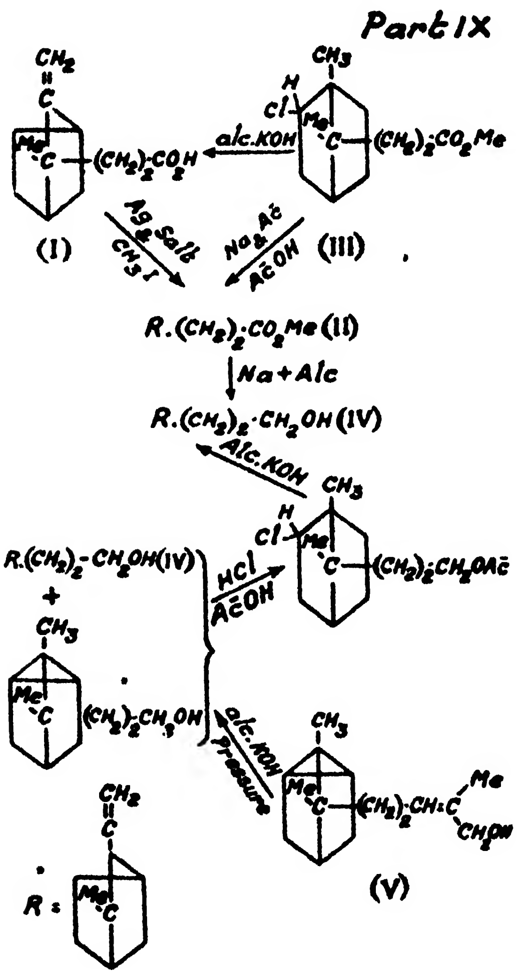
Organic Chemistry Section,
Dept. of Pure & Applied Chemistry,
Indian Institute of Science, Bangalore,
21-9-1946.

[1] Semmler, *Ber.*, *40*, 1120-1124, 1907; *43*, 1893, 1910.
[2] Ruzicka, *Helv. Chem. Acta*, *18*, 355, 1935.
[3] Simonsen, *J.C.S.*, 309, 1935.
[4] Guha and Bhattacharyya, *J. Ind. Chem. Soc.*, *21*, 271, 1944.

STUDIES IN THE SANTALOL SERIES

Part IX: Preparation of bicycloekasantalic acid and bicycloekasantalol.

BICYCLOEKASANTALIC acid (I) (see part I of this series) is produced by the treatment of hydrochloro-bicyclo-ekasantalic acid methyl ester (III) with alcoholic potash. The acid thus obtained needs about two fractionations before it can be obtained in a pure state. The methyl ester (II) is obtained through the corresponding silver salt and alkyl iodide. It has now been found that (III) on treatment with fused sodium acetate and glacial acetic



acid is smoothly and almost quantitatively converted to the methyl ester (II), b.p. 115-118°/5 mm.; d_4^{20}, 1·0194; n^{20}, 1·4880; $a = -26·8°$, thus eliminating the use of costly silver salt and alkyl iodide and also about three extra chemical operations. (II) on reduction with alcohol and sodium (6 atoms) gives bicycloekasantalol (IV), m.p. 120°/5 mm.; d_4^{20}, 0·9785; n^{20}, 1·5001; $a = -22·5°$. a-Santalol (V) on digestion with alcoholic alkali under pressure produces a compound by rupture of the cyclopropane ring which has some similarity with (IV)[1]. This particular reaction has been examined very thoroughly and the yield very much improved. It has been found that a-santalol on treatment with alkali produces actually a mixture (IV) and (VI), b.p. 115-120°/5 mm., the ratio of which varied and could be determined by measuring the amount of unsaturation with percamphoric or perbenzoic acid. The same mixture is produced by the total santalol fraction of sandalwood oil under similar conditions. This mixture of (IV) and (VI) by treatment with hydrochloric acid in glacial acetic acid produces a mixture of hydrochloro-acetate (VII) which with alcoholic potash forms (IV), which can be purified through its hydrogen phthalate. These comparatively similar methods of preparation of (II) and (IV) are important because of the fact that (IV) has been utilised as a starting material in our syntheses of β-santalol and allied compounds.

The author's thanks are due to Prof. P. C. Guha, D.Sc., F.N.I., for his kind interest during the course of this investigation.

S. C. BHATTACHARYYA

Organic Chemistry Section,
Dept. of Pure & Applied Chemistry,
Indian Institute of Science,
Bangalore, 21-9-1946.

[1] Semmler, *Ber.*, *20*, 1120, 1124, 1907.

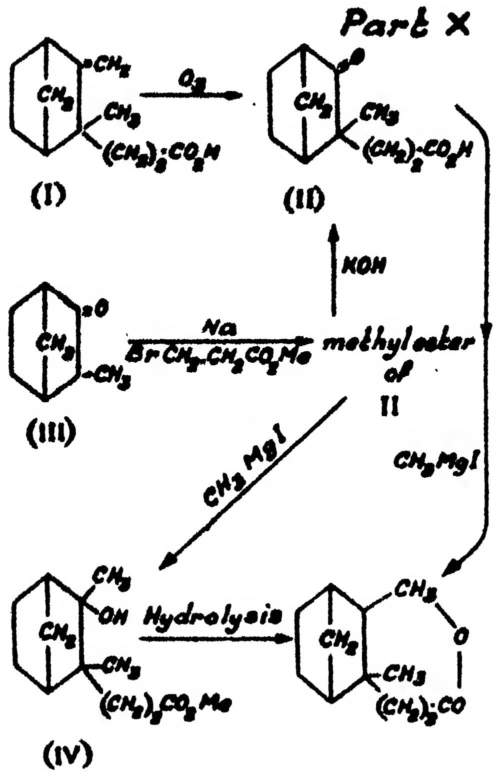
STUDIES IN THE SANTALOL SERIES

Part X: Syntheses of bicycloekasantalic acid and its Degradation Products

IT has been shown by Ruzicka[1] that bicycloekasantalic acid possesses the structure (I). On ozonisation it forms as one of the reaction products the liquid camphenilonyl acetic acid (II), b.p. 148-152°/1 mm.; methyl ester b.p. 138-139°/5 mm.; m.p. 77°.

The syntheses of (I) and II) has been achieved as follows: The sodium derivative of methyl norcamphor (III) prepared according to the method of Diels and Alder[2] reacts with one molecule of methyl-β-bromo-propionate to produce the methyl ester of (II), b.p. 138-140°/5 mm.; free acid (II) b.p. 148-152°/1 mm. This methyl ester on treatment with one molecule of magnesium methyl iodide is converted to a tertiary alcoholic ester (IV), the ketonic group having reacted preferentially. The free acid obtained by hydrolysis and acidification forms a lactone (V) (see part I, formula VI), b.p. 140-145/5 m.m.; m.p. 102°. The same lactone is also produced by the

action of two molecules of magnesium methyl iodide on (II) and subsequent acidification. The compound (IV) on refluxing with acetic anhydride or by heating at 200° with alumina or kiselgur is dehydrated to the



methyl ester of (I), b.p. 115-118°/5 mm., d_4^{20} 1.0190; n_D^{20}, 1.4882, free acid b.p. 150-155°/5 mm.; m.p. 62°.

The author's thanks are due to Prof. P. C. Guha, D.Sc., F.N.I., for his kind interest during the course of this investigation.

S. C. BHATTACHARYYA

Organic Chemistry Section,
Dept. of Pure & Applied Chemistry,
Indian Institute of Science, Bangalore.
21-9-1946.

[1] Ruzicka, *Helv. Chim. Acta.*, *18*, 365, 1935
[2] Diels and Alder, *Ann.*, *486*, 202, 1931

NUTRITIVE REQUIREMENTS OF *PASTEURELLA SEPTICA*

SEVERAL strains of *Pasteurella septica* have been reported to grow in a hydrolyzed gelatin basal medium when nicotinamide and pantothenic acid are added.[1] Two strains of this organism, isolated at this Institute, do not seem to develop in a hydrolyzed casein basal medium in the presence of nicotinamide and Ca. pantothenate unless an extract of liver is also added (Table I). Riboflavin,* aneurin, pyridoxine, biotin, folic acid ("folvite"), p.aminobenzoic acid, nicotinic acid, choline, adenine and inositol, added either singly or in combination cannot replace liver extract in supporting growth. Liver extract, therefore, appears to contain an unknown substance or substances essential for the growth of this organism. Serum as well as extracts of kidney and muscle tissues also support growth in the same way as the liver extract.

The hydrolyzed casein basal medium contained the following ingredients per 100 ml. Acid hydrolyzed casein (B.D.H., light, white, soluble) 1·0 g., sodium chloride 0·5 g., disodium hydrogen phosphate 0·2 g., magnesium sulphate 5·0 mg., calcium chloride 1·0 mg., glucose 0·3 g., valine, tyrosine, tryptophane, cystine, methionine and histidine 2·0 mg. each. The medium was adjusted to pH 7·0 -7·2 and sterilized by autoclaving at 10 lbs. for 10 min.

The accessory growth substances were sterilized by filtration through small, well-burnt porcelain candles and added aseptically to the basal medium The accessory growth substances consisted of nicotinamide, Ca. pantothenate, pyridoxine, riboflavin, aneurin, p. aminobenzoic acid, nicotinic acid (0·2 μg. each/ml); biotin, folic acid (0·01 μg. each/ml); adenine, choline, inositol, (0·01 mg each/ml).

The test organisms, Past. 52 and Past. 25, the former being virulent and the latter avirulent, were grown on blood agar for 24 hours at 37°C. A very thin suspension of each organism was made in sterile normal saline and 0·1 ml of it was added to 4·9 ml of the medium.

TABLE I

Composition of media	Growth of Past. 52 & Past 25 after 24 hours at 37°C
Hydrolyzed casein basal medium	Nil
Hydrolyzed casein basal medium +nicotinamide and Ca. pantothenate	Nil or very faint
Hydrolyzed casein basal medium +nicotinamide, Ca. pantothenate and liver extract	Profuse
Liver extract alone	Nil

The crude liver extract was made by heating minced goat liver with one and a half times its volume of distilled water (adjusted to pH 5·0) at 85°C for 10 min. with constant stirring and was finally sterilized by filtration through a Seitz filter or a porcelain candle.

Experiments concerning purification and chemical nature of the active substance or substances are in progress.

N. B. Das
J. S. Rawat

Indian Veterinary Research Institute,
Mukteswar, 7-7-1947.

[1] Berkman, S., *J. Inf. Dis.*, 71, 201, 1942.

* Riboflavin, aneurin, Ca. pantothenate, nicotinamide, nicotinic acid and "folvite" used in this experiment were given to us by Roche Products, Ltd., and Lederle Laboratories, respectively.

HYDROLOGY IN INDIA

I

The remarks passed by Mr K. Bagchi in the above article published in the July, 1947 issue of Science and Culture regarding gauge, discharge and rainfall-runoff-erosion observations so far as the rivers Damodar and Tista are concerned are not correct. For information the name of the various gauge and discharge observation sites in the Damodar and Teesta Valleys are noted below.

	Name of rivers	Gauge Site	Gauge, Discharge and silt observation site
Damodar Valley	Damodar	Ayre	Ramgarh
		Sonalapur	Sudamdih
			Chas Road
	Barakar	Tilaiya	Barhi (Dt. Hazaribagh)
		Maithon	Barakar (Dt. Burdwan)
			Barakar (Dt Hazaribag near Giridih)
	Bokharo		Danea
	Usri		Giridih
Teesta Valley	Teesta		Mamring
			Melli
			Teesta Bridge (Anderson Bridge)
			Coronation Bridge (Sevok)
	Rangit		Naya Bazar
			Champa
	Rangpo		Rangpo
	Ramam		Singla Bazar.

The observations at all these sites are taken throughout the whole year. Normally the gauge readings are noted at interval of every three hours (6 A.M. to 9 P.M.) and during high flood hourly gauge readings are observed. Discharge observations are ordinarily recorded twice a day but during high flood discharge observations are noted for three times or even more.

Rainfall-runoff-erosion observations are being carried on at the following sites:—

(1) Ramgarh
(2) Barakar (near Giridih)
(3) Sudamdih

These observations were started in 1944 for Damodar and 1946 for Teesta rivers.

S. Banerjee
M. Barman

River Research Institute, Bengal,
Anderson House, Alipore,
Calcutta, 1-8-1947.

II

The plans published by the Government regarding the Damodar and the Teesta do not contain the information given in the letter on which our writings were based. This was only natural because most of the stations were set up after the plans were ready. We are however glad to learn that the steps which were emphasized in the article are being taken.

K. Bagchi

Calcutta, 5-8-1947.

ZONES OF PROGRESSIVE METAMORPHISM IN EASTERN SIKKIM

A tract of country in eastern Sikkim enclosed within a rough quadrangle formed by joining Rangli, Rangpo, Nampung and Karponang (Phusum) has been examined particularly in the light of metamorphism of the rocks, which belong to the Dalings and the Darjeeling gneiss of Mallet.

Preliminary field work (mostly by C. Ray, who is working for an M.Sc. thesis under S. Ray) indicates the presence of (1) zones of progressive metamorphism in a series of rocks mostly argillaceous, as in the Darjeeling District to the south, and (2) two belts of granitic intrusion.

The zones of metamorphism have been mapped in the field with a rough approximation. All the six zones of Barrow *viz.*, (*i*) Chlorite zone, (*ii*) biotite zone, (*iii*) garnet zone, (*iv*) staurolite zone, (*v*) kyanite zone and (*vi*) sillimanite zone have been noted. The isograds have been roughly indicated (Fig. 1). Precision as to the position of the isograds can be obtained only through microscopic examination,

which is being done by C. Ray. Such examination may prove or disprove the existence of a separate staurolite zone depending whether kyanite be observed or not under the microscope with staurolite, which is visible in hand specimens. It may be mentioned that it has not been possible to map a separate staurolite zone in the Darjeeling District by Ray.[1]

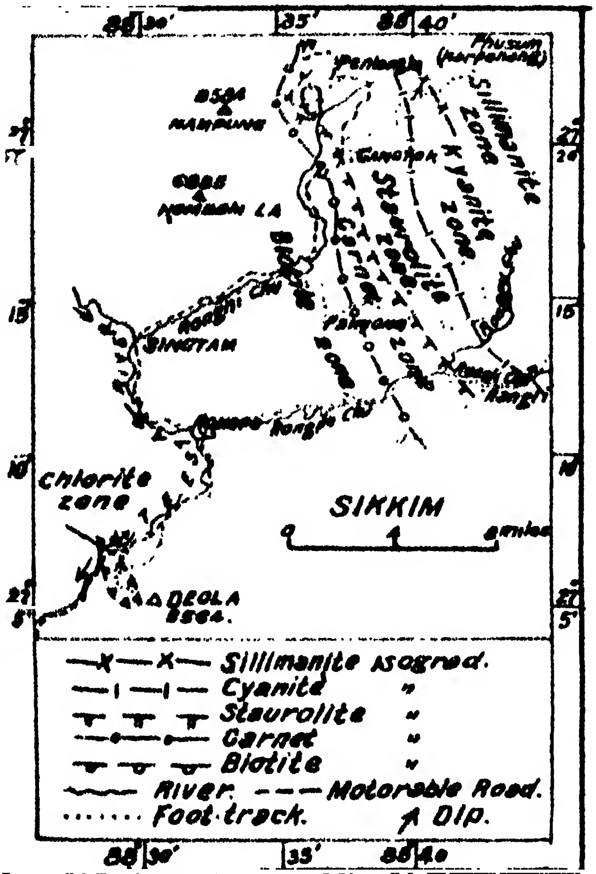


FIG. 1

As regards the granite intrusion Bose[2] mapped a band of gneissose granite about 2 miles wide between Murtam and Rumthek. It continues for some distance northward as well as southward for about 12 miles forming the serrated peaks of D, and Maphila. It was regarded as probably of intrusive origin.

Wager[3] noticed for the first time at Gangtok, a foliated granite with tourmaline and white mica, injected into rocks regarded as belonging to the Daling series.

But Auden[4] prefers to regard the granite of Wager between Gangtok and Dikchu as a gneiss. (It is probably the staurolite zone gneiss of the present note). The typical Sikkim granite is according to him always transgressive.

The present field examination[1] indicates two roughly N-S belts of granitic rocks separated by a width of schists. The granitic rocks have field characters more of an inter-foliar lit-par-lit injection of granite into schists, *i.e.* an injection gneiss, rather than that of a simple intrusion of a true transgressive granite mass. Laboratory study (in progress, by C. Ray) is expected to throw light on this problem.

S. RAY
C. RAY

Geology Department,
Presidency College,
Calcutta, 7-8-1947.

[1] Ray, S., SCIENCE AND CULTURE, 9, 353, 1944.
[2] Bose, P. N., *Rec. Geol. Surv. Ind.*, 24, 221-223, 1891
[3] Wager, L. R., Everest, pp. 320-326, 1933.
[4] Auden, J. B., *Rec. Geol. Surv. Ind.*, 69, 146-167, 1935.

ON THE FOOD OF *GLOSSOGOBIUS GIURIS* (HAM.)

THE problem of the nutrition of fish has in recent years received considerable attention, by the workers in all the countries of the world, due to the fact that the successful development of the fisheries depend very much on the supply of proper and wholesome food to the fish.

The results obtained from the examination of the stomach contents of sixtynine specimen of *Glossogobius giuris* varying from 13 mm.--130 mm. in size are briefly noted here. The specimens were collected from the river Rupnarayan at Kolaghat (during August--October, 1945 and 1946) and after proper preservation, as done by Job,[1] brought to Calcutta for study. The results of all examinations of stomach contents were analyzed stage by stage, based on the average of several individuals belonging to the same size and weight from young to adult, after a simple basis as followed by Pearse (cited by Breder and Crawford[2]) and the food-stuffs were divided into 6 main categories *e.g.*, *unicellular algae*, *multicellular algae*, *higher plants*, *protozoa*, *worms*, and *crustacea*. (Table I).

Analyzing the feeding habits from the above data it is observed :—

(1) At the earlier stages of development, the fish takes unicellular algae in a large proportion and is entirely herbivorous. Diatoms forms the main bulk of the unicellular algae. Multicellular algae and higher plants also plays important role in the menu.

(2) As the fish grows further, the percentage of the unicellular algae gradually decreases and the fish prefers the mixed diet, comprising of multicellular algae, pieces of roots and stems of aquatic plants, protozoa and crustacea. As the fish takes in plant food in greater quantities than the animal food it is still in herbivorous condition.

Table 1

Size	Weight	Number of specimens examined	Plants %			Animals %			Remarks
			Unicellular algae	Multicellular algae	Higher	Protozoa	Worms	Crustacea	
13 mm.	16 mg	5	60	13·3	26·7	..	..	...	Unicellular algae are mainly *Pleurococcus* and Diatoms.
15 mm.	23·2 mg.	5	11·6	72·2	11·2	...	.	.	Multicellular algae mainly *Spirogyra* and *Ulothrix*.
16 mm.	26 mg.	6	.	87·5	7·5	3·8		1·2	Artemia forms the crustacean diet.
17 mm.	35·6 mg.	4	..	8·4	86	1·6		5	
18 mm.	37·5 mg.	5	20	32·7	36	1·4	1·6	8·3	
19 mm.	40 mg.	3	4	85	2·5	1	...	7·5	
22 mm.	103 mg.	3	36·6	58·7	4·4	...	...		
33 mm.	306·6 mg.	4	3·3	46·7	3·2	11·8	...	35	
38 mm.	477 mg.	6	15	32·5	25	2·5	...	25	
50 mm.	912·5 mg.	5	15	..	5	5	..	75	
65 mm.	1922 mg.	6	25	..	.	5	..	70	
68 mm.	2560 mg.	5		70	.	2	..	28	
78 mm.	3336 mg	5		95	5		...	..	Mainly *spirogyra*, *ulothrix* and pieces of roots and stem of higher plants.
80 mm.	5775 mg.	3	15	10	10	.	..	65	
130 mm	15399 mg.	4		25	5	5	...	65	

(3) With further growth (*i.e.*, when 33—78 mm. in size) the fish is neither carnivorous nor herbivorous but omnivorous.

(4) From the above data it is concluded that the fish has the "selective habit"; when it begins to feed on crustacea and protozoa it decreases the intake of unicellular algae as food and prefers multicellular algae and higher plants instead. It can supplement one diet with any other in case of scarcity or non-availability of a particular diet. This is better understood when we consider the diet of 65 mm. and 75 mm. size where the record of the analysis is:—

65 mm.—unicellular algae 25 per cent, protozoa 5 per cent and crustacea 70 per cent.

78 mm.—multicellular algae 95 per cent, higher plants 5 per cent.

(5) The ratio of the animal and plant foods in the adults is approximately about 70 : 30.

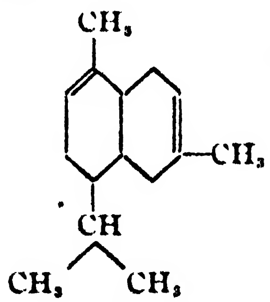
H. K. Mookerjee
D. N. Ganguly
B. Pakrasi

Fish Laboratory,
Department of Zoology,
Calcutta University.
14-8-1947.

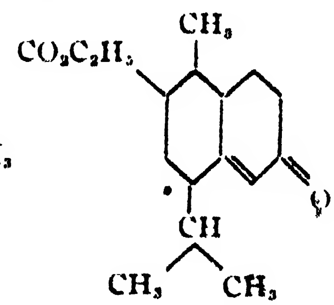
[1] Job, T. J., *Rec. Ind. Mus.* XLII, part 2, 1940.
[2] Breder, C. M. and Crawford, D. R., *Zoologica* II, 14, 1922.

EXPERIMENTS TOWARDS THE SYNTHESIS OF CADINENE

The experiments described in this communication were undertaken with the object of preparing synthetically the dicyclic sesquiterpene, Cadinene, which has been isolated from a number of essential oils. According to the latest work of Campbell and Soffer[1], the structure of this sesquiterpene is best represented by the formula (I).



I



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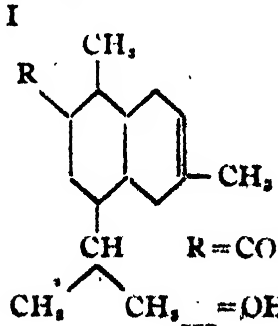

$R = CO_2C_2H_5$

$= OH$.

III

3-methyl-4-carbethoxy-$\Delta^{2:3}$-cyclohexanone was hydrogenated in the presence of Adam's catalyst

to furnish 3-methyl-4-carbethoxy-cyclohexanone.[2] This was then condensed with ethyl oxalate in the presence of sodium ethoxide and the crude glyoxyl derivative was heated at 180°C in the presence of soft glass powder till the evolution of carbon monoxide ceased, to yield ethyl-3-methyl-cyclohexanone-4:6-dicarboxylate (b.p. 134-35°C/3·5 mm.). The potassio-salt of this β-keto ester was then allowed to react with isopropyl iodide and the resulting ethyl-3-methyl-6-isopropyl-cyclohexanone-4:6-dicarboxylate (b.p. 135-37°/3·5 mm.) was then treated with 0·2 moles of sodium in calculated quantity of alcohol to yield the pimelate, ethyl-2-methyl-5-isopropyl-pentane-1:3:5-tricarboxylate (b.p. 145-46°C/3 mm.). This was then cyclized with sodium dust in benzene solution to furnish ethyl-3-methyl-6-isopropyl-cyclohexanone-2:4-dicarboxylate (b.p. 135-37°/3 mm.), the sodio derivative of which was then condensed with the methoiodide of 4-diethylamino-butan-2-one[1] to yield ethyl-3-methyl-6-isopropyl-2-(γ-ketobutyl)-cyclohexanone-2:4-dicarboxylate (b.p. 182-84°C/3 mm.). This diketo compound upon hydrolysis with alcoholic potash, ring closure and esterification furnished ethyl-1-methyl-4-isopropyl-$\Delta^{5:10}$-octahydronaphthalene-6-one-2-carboxylate (II, b.p. 140-43°/2·5 mm.).

This keto ester (II) on catalytic hydrogenation followed by treatment with methyl magnesium iodide and subsequent dehydration will furnish the decalin derivative (III, R = CO_2Et), the carbethoxyl group of which can be degraded to produce the decalol (III, R = OH) which upon dehydration is expected to furnish cadinene (I).

My thanks are due to Dr P. C. Mitter, for his kind interest during the course of this investigation. My thanks are also due to the University of Calcutta for the award of a scholarship from Sir P. C. Ray Fellowship Funds.

PRATUL CHANDRA MUKHERJI

Department of Chemistry,
University College of Science & Technology,
92, Upper Circular Road,
Calcutta, 23-8-1947.

[1] Campbell and Soffer, *J. A. C. S.*, 64, 417, 1942.
[2] Skita, *Ber.*, 42, 1631, 1909.
[3] Wilds and Shunk, *J. A. C. S.*, 65, 471, 1943, Ruzicka, Prelog and Wirth, *Helv. Chim. Acta.*, 29, 1425, 1946.

THE COMPOSITE CHARACTER OF JUTE FIBRE IN RELATION TO PHYSICAL TESTING*

STUDIES of anatomical development of jute fibre[1] have clearly shown the existence of two fundamentally different kinds of fibre in the jute stem. These are the primary fibres derived from the parenchyma cells of the primary phloem, and the secondary fibres separated from the cambium. These two kinds of fibre which constitute the jute of commerce are derived from two distinctly separate sources of origin. These also differ in structure such as length of elementary cells, the size of the lumen etc.[2]

The primary fibres constitute a very small percentage of the total jute fibre from a plant, and these occur about the periphery of the reed as obtained after retting. The bulk of the fibre is derived from the cambium.

In order to test jute fibre for various physical qualities it is necessary to break down the mesh structure which exists in the jute reeds by some quick process. The process in use[3] is that of hand combing against a coarse and a fine set of gill-pins. In course of combing by this process, a considerable amount of "tow" is formed. This "tow" being highly variable in length, and occurring in a tangled mass is difficult to utilize for test under the same *standard conditions* as the combed fibre. So, this tow has either to be tested under a different set of conditions or rejected. Before deciding on a particular alternative, it was considered necessary to investigate the difference in the physical and chemical characters of the two classes of fibre. The characters specially investigated were (*a*) the apparent density, (*b*) nitrogen content and (*c*) carbon-dioxide yield. However, before proceeding with these, the mass per unit length of single filament of the combed fibre and the tow respectively was also found on one variety (J 986 W) using the method reported earlier[4]. The fibre tested was derived from a low quality white jute (Q.R.* 52), and the following results were obtained.

	Mean Filament mass per unit length (microgm/cm.)	R.H. %
Combed fibre ..	$27·1 \pm 0·26$	76
Tow	$23·9 \pm 0·29$	75

The difference between the two values is highly significant.

The apparent density tests were carried out on 4 varieties of white jute of different qualities. The results are recorded hereunder.

Fibre Ref No.	Q.R.	Apparent Density					
		Combed Fibre			Tow		
		Mean (gm/c.c.)	R.H. (%)	Temp. (°F)	Mean (gm/c.c.)	R.H. (%)	Temp. (°F)
J 794W	85	1·288	64	78	1 281	63	78
J 1160W	93	1·236	71	76	1 196	69	77
J 1148W	100	1·268	70	79	1·240	72	79
J 1157W	102	1·265	67	77	1 226	71	77

These results clearly show that volume for volume the tow is lighter than the combed fibre. The results of chemical analysis carried out on two white and two tossa fibres, also point unmistakably to the existence of fundamental difference between the combed fibre and the tow. The results of chemical analysis which was carried out in the chemistry department are noted below.

Jute Ref No.	Q R	Nitrogen content (%)		CO_2 -Yield (%)	
		Combed fibre	Tow	Combed fibre	Tow
J 1002W	56	0 478	0·511	1 37	1 44
J 1079W	108	0·222	0·257	1 27	1 33
J 906T	81	0 318	0 322	1·33	1 35
J 938T	85	0 269	0 305	1·37	1 43

From the trend of these results it appears that the fibre which mainly forms the tow on combing is likely to be different from the combed fibre. Thus the present experiments show that the loss of fibre as tow in combing is likely to introduce a *bias* in the results of physical and chemical tests unless of course it can be shown that the kind of fibre which goes to form tow is an insignificant proportion of the total fibre. However, the combing data so far available show that the tow forms a considerable part of the jute under test This can be seen from the following tabulated values from an experiment.

Unit of combing†	Tow percentage	
	J 703(W)	J 574(T)
½	27 2	29·8
1	49 4	52 2

Undoubtedly part of the tow is composed of the fibre of the kind which mainly constitutes the "combed fibre". Even making allowance for it, the other kind of fibre which mainly forms tow, still seems likely to be considerable.

K. R. SEN,

Technological Research Laboratories,
Indian Central Jute Committee,
Tollygunj, Calcutta.
8-8-1947.

[1] S. S. Ghosh, K. R. Rao and J. S. Patel, *Agri. Res. Memoir* (I.C.J.C.) No. 1.

[2] R. L. M. Ghosh, Private Communication.

[3] C. R. Nodder, K. R. Sen and B. K. Chakrabarti, *Tech. Res. Mem.* (I C.J.C.) No. 2.

[4] K. R. Sen and C R Nodder, *Tech. Res. Memoir* (I.C.J.C.) No 7.

* Q. R. or Quality ratio $= 100 \times \dfrac{\text{Breaking load in lbs.}}{\text{grist in lbs./spy}}$ grist measures the count of the yarn and is the weight in lbs. of 1 spindle or 14,400 yds. length.

†The meaning of combing-unit is as given in T. R. Memoir, I.C.J.C No 7.

AGRICULTURE IN WEST BENGAL

MANY amongst us are not aware of the Agricultural decadence of Central and Western Bengal, which by the 16th century had been the zone of a dense population. But within a period of 40 years *i e.*, 1891 to 1931, Burdwan and Hooghly recorded a shrinkage of 50 and 60 per cent, and Jessore (now in the East Bengal) 33 per cent of their cultivated areas. Such a decline is perhaps unprecedented in the world. Out of about 86,000 villages of hitherto united Bengal, about 60,000 are habitual dens of malaria which accounts for about 35 per cent of total deaths. Sometime ago Dr Radha Kumud Mukherjee pointed out that the deterioration in Central Bengal has proceeded so far that a Government Irrigation Committee apprehend that it can not be checked and that the tract is doomed to floods, swamp and jungle.

Man's undaunted spirit must meet this challenge. Mr Elmhirst, who had been invited to advise on the Agricultural operations in Bengal, remarked that the backwardness in agriculture in Bengal is due to three main causes, –lack of economic lay-out of the fields or farms, the lack of perennial irrigation, and the malarial mosquito. If we can solve the problem of irrigation in a proper manner, we control malaria on one side and agriculture on the other, thus laying a true foundation of our rural prosperity. But the conditions of our rivers and water courses are simply appalling. In Central Bengal the rivers are dying, and in Western Bengal the majority are seasonal drainage channels for rain waters. Pandit Nehru, said in his memorable broadcast on the 15th August last that Government have in hand several vast schemes for developing valleys for controlling the rivers, building dams, and developing hydro-electric power. In Bengal these call for speedy implementation in order that the fearful decadence there can be arrested. No country is in such dire need as this unhappy part of Indian Union.

In the post-war reconstruction plan put up by the late Government of Bengal, land development schemes visualized the development of waste lands in Western Bengal, where some 1000 square miles

were estimated to have been lost to cultivation. It was contemplated to bring two lakhs acres of waste land under the plough, under a Provincial Land Utilization Scheme. Regarding reafforestation a beginning was contemplated in the Nadia District to be followed in other districts of West and Central Bengal if the scheme succeeded. We do not know what steps have since been taken and how matters stand now. There is much in common with Bengal, Bihar, Orissa and Assam, and as Professor M. N. Saha said, while commenting on the Bengal Post-war scheme, if all the potentialities of water power in all the adjacent areas can be developed, East India can develop into one of the major industrial centres of the world. I may add that such a course will usher an unprecedented prosperity to all these Provinces. According to recent calculations the density of population per square mile and per gross cultivated square mile in West Bengal are 750 and 1,005. In order to provide adequate food for these teeming millions we have to produce more, or we are deemed to perish. By the provision of irrigation facilities and manure, we can push up our production. If this is conducted in earnest, it will release a reasonable portion of our cultivated area. Part of it in selected areas (in the Midnapore district in particular) will have to be allocated for jute. At present Mymensingh district grows the best jute, but with proper care some areas of Midnapore should be able to grow an equally high quality jute. This will solve the problem of our mills. We have to make a survey of our waste land and depending on their situation, accessibility, and other factors utilize these for afforestation, fuel supply, fodder plantation, grazing area or other suitable purpose. In short they have to be on a co-ordinated plan in which agriculture, forestry, public health, communication, industry and other relevant aspects will find their legitimate place for mutual collaboration and collateral development.

Only the other day the Famine Commission remarked that apathy and defeatism were too prevalent in the past. The new spirit and the new determination which independence instinctively infuses must bring a radical alteration.

I. CHATTERJEE

Indian Council of Agricultural Research,
New Delhi, 25-8-1947.

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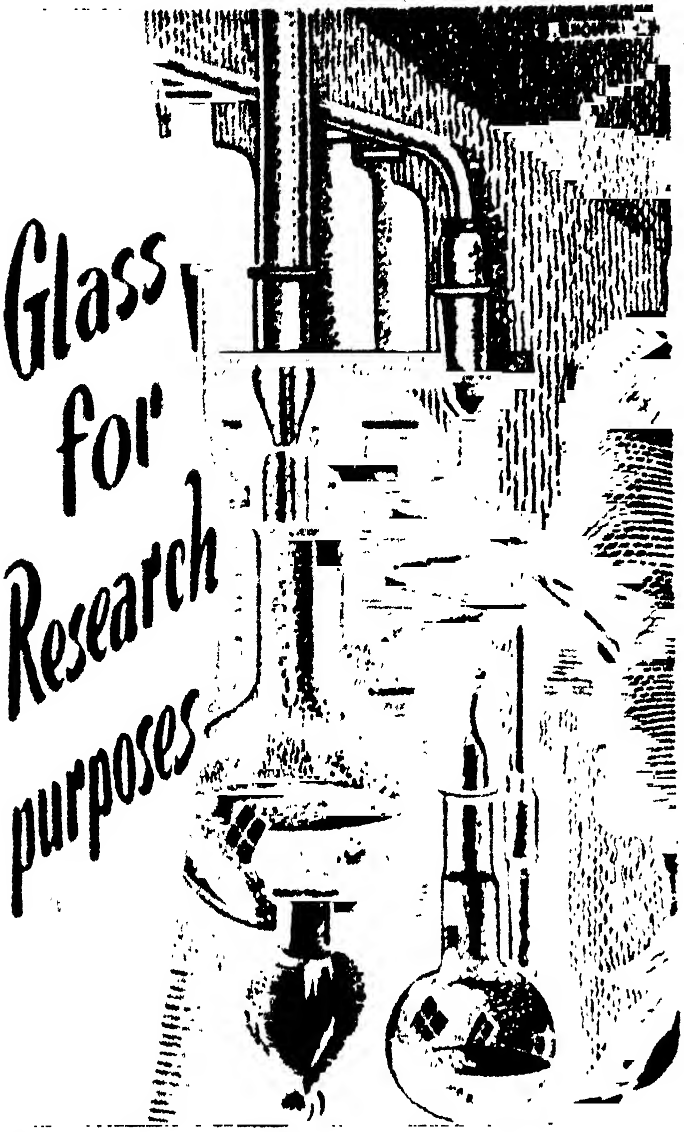

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Vol. 13, No. 5] [NOVEMBER, 1947

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SCIENCE AND CULTURE

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RELEASE OF ATOMIC ENERGY

SINCE the dropping of the atom bomb with its devastatingly destructive effect upon the unfortunate cities of Hiroshima and Nagashaki, the human mind has been overtaken with a bewildering perplexity as to its possible future application and development. Three influences have been at work over it, the politicians and the military leaders of the various States who have found in it a weapon of warfare which has eclipsed beyond imagination all the destructive devices of men, the scientists who foresee therein a new fascinating field of investigation for harnessing Nature's power to human welfare, and the common people who view it as an awful menace to society, civilization and the world at large. The final shape which this release of atomic energy will give to human destiny will depend, therefore, on the dominance of any of these influences over the others. If the politicians and military leaders can have their way and enforce the co-operation of the scientists taking advantage of the usually inert public opinion which seldom effectively asserts or can assert itself, then the prospect is obviously very grim. Though only the U. S. A. are now in possession of the means and the methods of production of atomic bomb, there is, however, no secrecy about the knowledge on which it is based. In fact, the fundamental physical principles relating to it were discovered mostly by the scientists of other countries. The successful application of these principles to the production of atom bomb in the U.S.A. might be attributed primarily to her immense industrial capacity, better opportunity for investigation in a comparatively peaceful surroundings more or less beyond the range of enemy attack, superior organization of high level scientific research and willing co-operation of many eminent foreign scientists some of whom were expelled from the Continental Europe, or escaped from the concentration camps of Hitler and Mussolini, and above all to the unstinted and unlimited financial support from the State. But there is no likelihood that this production of atomic bomb will ever remain confined to the U.S.A. alone. Scientists and competent authorities on the subject are of opinion that other countries might as well in no distant date be able to compete with the U.S.A. in this respect, provided the requisite scientific personnel, industrial and financial resources be available. And with this end in view preparations have already been set afoot in all the great sovereign States of the world today. This conceptual competition sooner or later is bound to end in a practical race in atomic armament among the nations with what disastrous effect upon the society and civilization it is dreadful to contemplate. Nay, further progress in scientific research may lead to the development of cheaper methods for the production of atom bombs and even of weapons more powerful and deadlier than the latter. The humanity is thus faced with an unprecedented peril ; and the situation becomes darker still when it is remembered that the scientists have failed till now to discover any protection or defence against this diabolical device of human destruction. All attempts by the United Nations to avert this peril have yet led to no fruitful results as can be gathered from their discussion, which has rather disclosed to the dismay and despair of common man a more or less insuperable barrier of distrust, jealousy and suspicion among the big powers. The scientists too cannot shirk their responsibility in this grave affair as they themselves were major partners in the production of the atom bomb. They have raised a Frankenstein and are now at a loss how to bring him under submission. It is little consolation to the common man, now groaning under the dreadful effect of a terrific world war fought for the avowed object of freedom from fear, want and disease but which has resulted simply in intensifying and magnifying the latter, when pictures of future peace, prosperity and progress are presented to him in abundance, in season and out of season, by the scientists

and State authorities in their August gatherings and conferences; for common men have had too bitter experiences of the past to be encouraged by any such promises for future.

It cannot be gainsaid that scientists in every countries have become the willing and obliging tools at the hands of their State authorities for the purpose of war. This has undoubtedly contributed a great deal to the development of science and its organization. As one of the earliest instances of this, mention may be made here of the birth of the National Academy of Sciences in the U.S.A. during the days of civil war when President Lincoln sought the active help of the scientists. During the world war of 1914-18, there was a large mobilization of scientific personnel; but the most efficient pooling and organization of scientific resources and personnel were brought about during the last global war in the U.K., the U.S.S.R. and particularly in the U.S.A. In the last-named country the organization, known as Office of Scientific Research and Development (O.S.R.D.) was established through the initiative of President Roosevelt under the Directorship of Vannevar Bush. The manufacture of the dreadful atom bomb was the outcome of this organization.

The power and energy thus released from nature by the devoted work of the scientists have only been utilized and usurped by the political authorities for their own ends, with results which have served ultimately to multiply human sufferings and human misery rather than contributing to human welfare. Search for truth and the extension of the boundary of human knowledge for the service of humanity which form the primary objective of science, are thus prostituted for infamous and ignoble ends. No better illustration of this can be quoted than the explosion of the atom bomb; and no greater vile or criminal application of a great and magnificient scientific discovery could have ever possibly been made. This has rudely shaken the conscience of the scientists today and they are gradually becoming alive to their responsibility. Though the results of scientific researches are calculated to advance the march of civilization and improve the conditions of living and amenities of life, the scientists, since late nineties, have been the melancholy observers of what man has made of the fruits of their devoted studies. While the average standard of living has gone up to a great extent, individual and collective greed for power and gain, as a result of maldistribution of profit and wealth, both among individuals as well as among different nations, a state of perpetual conflict and competition among the various rival groups has been the order of the day all over the world. The world is thus dominated today by limited groups of men with power and wealth. Many are forced to lead today a life of misery, suffering and shame, so that a few may live with pleasure, plenty and power. For, the common man has seen no better luck in life than the presence of heavy army and police boots coupled with the scarcity of common necessities of life. The abuse of power, thus derived from the application of science, has now reached its limit in the manufacture and dropping of atom bombs; and, unless checked in time this may ultimately lead to the extinction of modern civilization. Scientists have now realized their own responsibility in this development and are now bent upon devising ways and means for effectively dealing with the situation. This is illustrated by the following quotation from Arthur H. Compton:

> "The world-wide growth of science and technology is the main line of the rapid evolution of man into a social being whose community is the world. . . . We now have before us the clear choice between adjusting the pattern of our society on a world basis so that wars cannot come again, or, of following the outworn tradition of national self-defence, which if carried through to its logical conclusion, must result in catastrophic conflicts."

We may also refer here to that eloquent letter of Albert Einstein which we had the privilege to publish on the cover of our August issue.

We have before us the first of a series of packets which the Association of Scientists for Atomic Education through its Committee for Foreign Correspondence propose to send out to all countries of the world. In the present connotation of the term, the Association will have 'political' work so far as they will attempt to bring about agreement amongst the nations' representatives at the U.N.O. educating public opinion and mobilizing that opinion for 'political' pressure. The Committee has been sponsored by more than a score of eminent scientists, most of whom once worked whole-heartedly in the atom bomb projects in one or the other of the three U.S. stations. By an appeal broadcast to the nation by Albert Einstein on behalf of the Association, a fund has been created for the Einstein Emergency Committee of Atomic Scientists, and financial assistance from this Committee has enabled the first mentioned Committee to function. The letter sent with the packet states:

> "The work of the Committee is directed toward creation of sufficient confidence among the nations to permit the operation of an international system of atomic energy control. This confidence has been seriously undermined by the events of the past months. People of other nations may find much in the policy of the United States which is disturbing, particularly in view of the military demonstrations by our Government of the power of the atomic bomb, and of the continued manufacture of atomic weapons. As a result, national isolationism may become dangerously strengthened everywhere just when a rapid extension of international co-operation on an unprecedented scale is essential to peace."

"Scientists of all lands have a unique opportunity and responsibility to contribute toward international co-operation. Natural scientists in particular have developed a rich tradition of international fraternity, and we must all take specific steps to renew and strengthen this tradition and to widen its foundations. The Committee hopes that by this letter, and by the sending of regular information on developments in this country on atomic energy control, you will be convinced of the sincere support of American scientists in our common fight for world peace and true international understanding. It is toward this goal that this letter is being sent to you and to other scientists all over the world. We urge you to publicize as widely as possible the contents of this letter and of the other material which you will receive. In exchange, we should like your permission to make public any suggestions and criticisms you may propose."

A Federation of American Scientists has been formed to meet the increasingly apparent responsibility of scientists for promoting the welfare of mankind and the achievement of a world state. Their direct contribution to the present power of unlimited destruction has raised the problem to a head for the scientists' immediate concern.

Science and scientists have thus come to be very directly and intimately involved in matters of policy affecting the general welfare and world peace. Scientists must accept immediate individual and social responsibilities and should prepare to discharge them. Science has never known sectional boundaries and as members of international fraternity we consider that it is time Indian scientists took upon themselves the task of organizing an actively aware body like the Federation of American Scientists. The nature and ambit of our work will be much wider. At the beginning much spade work has to be done by sponsoring immediate educational work both among fellow scientists and the common people. For such a scientists' organization as suggested above we may have in common the following 4 aims:

1. To study, in consideration of the broad responsibility of the scientists today, the implications of any scientific developments which may involve hazards to enduring peace and the safety of mankind.

2. To counteract misinformation with scientific facts and, especially, to disseminate those facts necessary for intelligent conclusions concerning the social implications of new knowledge in science.

3. To safeguard the spirit of free inquiry and free interchange of information without which science cannot flourish.

4. To promote those public policies which will secure the benefits of science to the general welfare.

Science does not mince matters and some of us may be complacent that as scientists we have developed 'social awareness' and we are directing our energy and study to social welfare. But the execution of the policy underlying the directive must also be taken by them who know what a scientific result means and how it can be brought to fruition. It is time that scientists took a stronger stand and control the group, distinguished as 'politicals', who are now shaping or shattering the society. Civilization, which is the product of scientific efforts, is challeneged today. Hence it is the primary duty of the scientists to exert their best efforts for safeguarding and maintaining the civilization.

परमाणु सम्बन्धी वैज्ञानिकों की [illegible] कमिटी*

कमरा नं० २८, ६० नासाऊ स्ट्रीट
प्रिन्सटन, न्यूजर्सी (अमरीका)
३० अप्रेल, १९४७

प्रिय मित्र,

मैं एक मित्र की राय पर आपको कुछ सहायता के लिये लिख रहा हूँ।

परमाणु संबधी शक्ति को मुक्त कर के हमारी पीढ़ी ने इस संसार में पूर्व ऐतिहासिक अग्नि के [illegible] के समय से अब तक की सब से बड़ी क्रान्तिकारी योजना पैदा कर दी है। ब्रह्मांड की इस मुख्य शक्ति का संकीर्ण [illegible] के विचारों से मेल नहीं बैठ सकता। क्योंकि इस में न कोई छिपी हुई बात है और न इस से कोई बचाव। जनता की जागृत बुद्धि तथा उसकी दृढ़ता को छोड़कर इस शक्ति को बस में रखने के किसी और उपाय की सम्भावना भी नहीं है।

* The original letter in English appeared on the cover page of the August, 1947 issue of the journal. A translation of the same in Hindi is being reproduced here for wider circulation.—*Ed. Sci. & Cul.*

हम वैज्ञानिक जनता को इस शक्ति की प्रत्यक्ष बातों तथा समाज पर उनके प्रभाव को जता देना अपना परम कर्त्तव्य समझते हैं। केवल इसी में हमारी रक्षा और इसी में हमारी भविष्य आशा है—क्योंकि हमारी धारणा है कि समझी बूझी हुई जनता जीवन के लिये अग्रसर होगी न कि मृत्यु के लिये।

हमें इस कार्य्य के लिये दस लाख डालर (लग भग ३५ लाख रु०) की आवश्यकता है। मनुष्य के अपने प्रारब्ध को तर्क से काम ले कर बनाने की शक्ति पर विश्वास रखते हुऐ हमने इस काम में अपनी सारी शक्ति व ज्ञान लगा देने की प्रतिज्ञा की है। मुझे आप से सहायता की प्रार्थना करने में कोई संकोच नहीं होता।

आपका

ऐल्बर्ट आइन्सटाइन

(प्रो० मेघनाद साहा को प्रो० ऐल्बर्ट आइन्सटाइन के पत्र का अनुवाद) जो सज्जन इस शुभ कार्य्य में दान देना चाहें, वह निम्नलिखित पते पर भेजने की कृपा करें।

सम्पादक

साइन्स ऐंड कलचर

९२, अपर सर्क्यूलर रोड, कलकत्ता

PLAN FOR CULTURAL UNITY*

JNAN CHANDRA GHOSH,
DIRECTOR, INDIAN INSTITUTE OF SCIENCE, BANGALORE

THE political unity for which our people made great sacrifices a generation ago, ceased to exist on the 15th of last August. A people speaking the same language and belonging to the same racial stock, have decided that they are two nations because they profess two different religions. It is a miracle that they have parted in peace. Under the leadership of the Mahatma the citizens of Calcutta and the people of Bengal have demonstrated that miracles can also happen in the twentieth century. By this act of reconciliation they have covered themselves with glory. What better national memorial can we raise for the Mahatma on the completion of his 78th year than this that we all dedicate ourselves to the proposition, that though political boundaries may divide Bengal into two, we shall preserve the cultural unity of Bengal; that we Hindus and Muslims—it does not matter whether we owe allegiance to Calcutta or Dacca—would retain the same outlook on life, the same modes of expression, the same feeling of kinship, and as recent events have amply demonstrated, the same toleration, sentimental exuberance, emotional fervour and reckless idealism which we claim as the common heritage of our race. But for permanent reconciliation for the stabilization of peace, a permanent organization is necessary. For this purpose we require a United Bengal Educational Scientific and Cultural Organization, (UBESCO) which will transcend all political considerations, which will evoke the loyalty of every Bengalee and which will become the most powerful and ever-growing influence in shaping our minds.

How Evils of Partition can be Mitigated

In another unfortunate part of India, partition has been attended with the most disastrous consequences. A barbarous civil war has made imperative, migration of people running to many millions; and all the resources of the Governments of India and Pakistan are now being devoted to the solution of many problems that this forced migration has raised. Ministries of Resettlement have been established and no expenditure is considered too high which aims at

* Adapted from the Convocation Address delivered at Calcutta University on October 3, 1947.

making a success of this job. Let us pray that we in Bengal shall escape the terrible experience of the mass uprooting of people. Let us pledge ourselves that we shall resolve our differences by discussion, by persuasion and compromise. Let us pledge ourselves that the boundary that separates Bengal into two, shall ever remain as peaceful as the boundary between the United States of America and Canada. I have crossed and re-crossed that boundary many times ; there is no fortress, no sentry to be seen anywhere on that long line of 3000 miles which in school maps is supposed to be the boundary between the United States and Canada. Let us pledge ourselves to educate our people in such ways that a conflict at this boundary would be as unthinkable as between the peoples of United States and Canada. Let us urge on the government to place at the disposal of the UBESCO (United Bengal Educational Scientific and Cultural Organisation) such resources, say at least two crores of rupees, a year, which will make it a powerful and living organisation, ranking in importance with the Mnistries of Resettlement in the Punjab and competent to tackle successfully the vast problems of reconciling the people in the eastern frontier of India who have parted company.

Interdependence of various parts essential for prosperity

Men in high places are not wanting who doubt if such a reconciliation is possible. I have met hundreds of responsible leaders of East Bengal who have come to Calcutta and who have such doubts. I do not despair. As educationists we have an advantage. We recognise that there are four phases in the development of a human being—the phase of early dependence in childhood, and then adolescence when a boy and also a girl struggles to be free from all restraining influences and is often wayward and unaccountable. Then early youth when he plants his flag of independence and sets sail alone on the voyage of life; and finally maturity when he proclaims that interdependence is the basis of all stable social relations. A parent as also a teacher thanks God that adolescence is a period of temporary insanity. A nation also passes through similar phases of development. India has outgrown the childhood of dependence on Great Britain. Independence has been gained but its free implications have not yet been realised, and if at this stage, the action of a section of our people appears to be unaccountable, such action represents the temporary insanity of an adolescent people. But we are confident that when our people have enjoyed for sometime the freedom, that they have gained in the ways they have selected, they would proclaim that the interdependence of the various parts of the geographical unity, that is India, is essenial for the rational solution of the many problems that face a resurgent country.

I am reminded in this connection of the story in Indian mythology, how at the dawn of life in this world, the oceans were churned and the first thing that came out was the *Halahala*, the most malignant poison, and the last thing that came out was *Amrt*, the nectar. The Great God swallowed the poison so that His creation may endure. He became *Nilkantha* (poison-throated).

Switzerland, France, Germany

It is not a matter of surprise therefore that at the dawn of a new era in India when the ocean of human life is being churned when an old order is crumbling down and a new order is struggling to be born, some poison would come out. But unfortunately, there is no God in our midst to swallow the poison, for modern man believes that God helps those who help themselves, that human intelligence is a spark of the divine and that man must draw upon the accumulated fund of the experiences of his fathers for inspiration to deal with such poison. I shall not be a fool to rush in, where angels fear to tread and prescribe an antidote to this poison ; but I cannot help recounting some feelings which I experienced when I mused on this problem a year ago in a historic spot in Europe. I happened to be in Basle, a prosperous town in Switzerland, famous for its chemical and electrical industries. There, even a scientist is sometimes lured to the beauty spots of Nature ; and the bank of the Rhine as it flows swiftly down the Alpine hills and changes suddenly its direction from the west to the north to debouch into the plains of Germany was my favourite haunt. At this corner three countries of Europe meet. As you face north, towards your right, in front of you, lies Germany whose people intoxicated with pride and power sought to dominate Europe twice in one generation, now laid in the dust nobody knows when to rise again to her full legitimate share—the flower of her manhood dead and gone, a land of crippled men, emaciated women, stunted children clad in rags and begging for food—a lamentable fate for a great and gifted people who have made undying contributions in many spheres of arts, science and industry. Towards your left and again in front of you lies France, her people waking up just from a nightmare of five years' slavery, the present generation very much unlike their fathers of 1792 who swore to immolate everyone who breathed a proposition to surrender, who dared and always dared to conquer the enemy—a land now prey to petty jealousies which foreign domination breeds, a paradise for black marketeers indifferent to the sufferings of the honest poor. These two countries present to

you a fearful spectacle of what man has made of man, how civilization has crumbled down under our very eyes because of open conflicts and hidden stresses.) But behind you lies Switzerland, easily the most prosperous country in Europe today, picturesque beyond imagination, where the wondrous beauties of Nature have been perfected by the handiwork of man, and also woman is engaged in gainful occupation and looks pictures of health and happiness. Yet Switzerland is a sovereign State whose people belong to three national stocks, Germans, French and Italians, who speak three languages and profess two religions. The German speaking Protestant Swiss however does not think of a French speaking Roman Catholic Swiss as his hereditary enemy but embraces him as a dear neighbour, each intensely proud of his Swiss nationality. Religion, language, social customs---words, mere words! They are not afraid to look these words in the face. It is the man behind that matters. They in Switzerland recognise that it will be a dull world of theirs if it were to contain one uniform type of population. A landscape is not worth looking at if it features a uniform plain. They consider that diversity instead of giving rise to disruptive influences should be welcomed as the salt of life, should be welcomed as containing in it the seeds of greater progress; and based on this philosophy of life they have built up a civilization which is rich and picturesque as a mosaic the State is nonetheless strong and secure in the affection and loyalty of a people whose heterogeneous elements have been bonded together by the cementing forces of good will and fellowship as in a mosaic. Of course, the people of Switzerland have an advantage not given unto mortals elsewhere. As they lie on the ground gazing upon the scene surrounding them, stupendous cliffs capped with pure white dazzling snow, glaciers radiant in the sunshine rolling down to feed the calm clear lakes below, the smiling valleys around and the blue sky above—they offer spontaneously a prayer of thanksgiving to Heaven that it has been given unto them to enjoy such glories everyday. Such communion with Nature builds up subconsciously a high standard of human behaviour, and the shifting scenes of political landscapes create little impression on minds attuned to the eternal glories of Nature's landscapes.

Programme of the UBESCO

With our Chancellor as the first President of the UBESCO I envisage that the Calcutta University will become one of its most powerful organs. I recommend this idea of UBESCO to the Vice-Chancellor and the Senate and I hope that before long a concrete plan of action will be evolved which will be welcomed by the intelligentsia of Bengal and by the Governments of the country. Let the University of Calcutta continue to welcome with open arms students from all over Bengal and also India, as the University of Paris or as the Vice-Chancellor called it the University of Abeland—that great name among the teachers—in the early days of Christianity welcomed students in thousands from all over Christendom.

Let the welcome which we offer to these students be not niggardly in any way. I suggest with all emphasis that the UBESCO should build for them students' homes in the city of Calcutta on the model of the international students' homes of the Rockefeller Foundation. The slums in Calcutta are too many and are a disgrace to the people and to the Government. They are danger spots in more sense than one and the people there should immediately be transferred to very decent surroundings in the suburbs. The landlords who have grown fat on the earnings of these miserable slum dwellers may be dismissed with small compensation. And the land thus made available should be handed over to the UBESCO for building these students' homes. When I speak of such homes I do not really have in mind college hostels as they exist today but modern residential units open to youngmen of all religions, Hindus, Muslims and Christians, which will in the fullness of time like powerful light-houses, beckon to the youth of Bengal to gather there, join in the festival of life and salvage of all that is precious in our cultural and community life from the shipwreck of partition, where youngmen will imbibe as a part of their being the things that are excellent, in the language of the Poet

> The gains of Science, gifts of Art . . .
> The Sense of oneness with our kind
> The thirst to know and understand
> A large and liberal discontent.

I would plead that the students' homes may be run by the UBESCO on the principle that poverty should be no bar to young talent reaching its highest fulfilment. Every modern enlightened State recognises that the worth of a State is the worth of the individuals composing that State; and in Russia if a person is worth educating beyond the age of adolescence he is educated and maintained at the cost of the State. We shall do Bengal any amount of good if we can implement at least partially this principle into our educational system.

National Planning and Occupational Institutes

I yield to none in my enthusiasm for higher cultural and scientific education, but I feel that it does Bengal little good if all our enterprising youngmen flock to the University after completion of high school education. The Vice-Chancellor has referred to the criticism levelled at the University for having

swelled the rank of unemployment. I believe in National Planning, as the shortest and quickest means of developing the resources of the country now running to waste. Such planning alone can solve the problems of a rich country inhabited by a starving people ; and I hope that the freedom which we have gained will be used in carrying out intelligently beneficient national policies. The bottleneck here is capable men who must be produced in maximum abundance and maintained in maximum activity. Besides leaders who are capable of inspiring people to noble efforts and formulate high policies, we require able administrators who will execute successfully such plans, and skilled workers who will make a success of these jobs. In a well planned social and economic organisation a student of today is as much a worker as a citizen of tomorrow, and for the majority of them there should be a place in a factory or an office or a firm, earmarked well in advance of the completion of their studies. No one wants today to eat the bread of idleness ; and our educational system should be so integrated with national planning that every educated person should be secured, freedom from fear of unemployment. This fear is far more crippling to our youngmen than even fear of want and any system of planning which aims at removing such fear should have priority over every other programme of nation building activities. In Bangalore under the guidance of Sir M. Visvesvaraya we thought that a large section of the matriculates should be diverted from stereotyped intermediate colleges into occupational institutes of a new design. Analysis was made of the more important occupations in South India which require skilled workers having a high school education ; and one after another, 25 such courses were introduced into the occupational institute at Bangalore in order of their relative importance in the labour market ; and I am very glad to state that the trainees from this institute have been absorbed in gainful occupations much faster than they have been produced. This institute has captured the imagination of the people of Mysore. Educationists, philanthropists and local bodies are pressing on Government to open similar institutes in other parts of Mysore promising to subscribe locally a part of the capital cost of building and equipment.

An Occupational Institute for Calcutta

I would urge on the Government of Bengal to carry out this experiment on right lines in Calcutta and if found successful, adopt it on a very large scale all over the province. Such training is very expensive. The Occupational Institute at Bangalore has already cost us 23 lakhs of rupees and it is estimated that the ultimate cost will be about 40 lakhs of rupees, which will provide training of one thousand day scholars and also about one thousand evening scholars. I do hope that the Government of Bengal will not be frightened by such scale of expenditure. I would recommend to them the example of France where a tax equivalent to 3% of the wages bill has been imposed on all industrial and business concerns in order to obtain the funds which will provide such education. Such a tax is equitable as its proceeds are entirely devoted to the training of youngmen who will ultimately become skilled operatives in such business and industrial concerns.

Need for New Home for Scientific Work

Of course it is not the business of the University of Calcutta to promote this type of technical education. But if I were to pursue my thoughts further I would suggest, and suggest very strongly, that the Government of Bengal may be persuaded to take over the land and buildings of the two sections of the University College of Science into an occupational institute at Calcutta, and that the University in its turn may be paid sufficient funds which will enable it to open a residential University College of Science with the most uptodate laboratories in the suburbs of Calcutta. The present laboratories will have to be in any case renovated beyond recognition and expanded very considerably if Calcutta were to provide modern facilities for research and post-graduate training in science.

It is an education itself for a University student to live and grow up in tune with the life of the community whom he intends to serve after the completion of his education. As a matter of fact I do hope that the University would have far more intimate and organic relations with the life of this city. The Vice-Chancellor has deplored the contraction in the area of the jurisdiction of this great University. I do not feel unhappy like him. I believe that the contraction of the area over which the University extends its jurisdiction offers for more compensating advantages than difficulties. I ultimately envisage a University of a teaching type for the city of Calcutta itself. In the course of evolution the Mammoth of ancient times has yielded place to modern man ; and I believe, this has been a progress in the right direction.

This is a colossal enterprise but we should remember that we are heirs to traditions of great enterprises having been successfully executed in the past by our illustrious heroes. For instance it is said that the river on which this city stands, which gives it sustenance and life, was not there according to one view, some 3,000 years ago. A great king Bhagirath by name is said to have won the favour of the gods by his unparallelled devotion and was given the strength of a Titan. This strength he used for

transporting this mighty river over a land where under a curse the jungle had swallowed civilized life. The river drained away the salt marshes, gave communication to the sea, fertilized with sweet water the soil, which bore rich crops and thus laid anew the foundations of a new civilization. Hence this sacred river is called Bhagirathi. And now that a greater curse—that of slavery, has been lifted from the land and the ground has been cleared for raising the structure of a new life for our people, can we not conjure up in our imagination the vision of this mythical hero whom our fathers conceived and rediscover the spirit with which he served the Motherland, boldness in planning, thoroughness in execution and hand to work, heart in God?

I do not presume to give you any advice; but I pray and wish you all to join in my prayer that each one of you may become a Bhagirath, may have his boldness in planning your life's work, may attain his thoroughness in executing these plans, that each one of you may practise with all your strength the *Yoga* which Lord Krishna preached as efficiency in action. It may be given unto some of you to devote your abilities to next schemes of reconstruction as administrators, engineers, scientists and medical men; it may be given unto some of you even to transport mighty rivers through barren lands and malarial swamps; but whatever may happen, it is given unto everyone of you to do what is equally important and more urgent today—transport little streams of sympathy into the lives of your neighbours, transport little streams of fellowship and good will into the lives of different communities and drain away the filth of suspicion and distrust. May you all, with malice to none and charity for all, with hand to work and heart in God, march on the road of new life singing, rejoicing, with the Poet of the new age:

It is a bliss to be alive in the dawn
But to be young is very Heaven

I, who am not young, wish you well, with all my strength.

HIMALAYA CO-OPERATIVE SNOW SURVEYS

J. E. CHURCH,

ADVISOR, HIMALAYA SNOW SURVEYS, CENTRAL WATERWAYS, NEW DELHI

WITHIN the present year signboards will appear high up the slopes of the Himalaya marking the snow survey courses which in the future will indicate the annual snow cover of the Himalaya upon which India must depend until summer monsoons arrive.

The word "Cooperative" is found throughout the mountains of North America where the Federal and State Governments (U. S. A.) unite in forecasting the flow of the snow-fed streams. This word should be particularly happy in the Himalaya where the streams rise in one state but are used in another. In like manner as international cooperation exists between Canada, the United States and Mexico particularly on the Columbia, Colorado, Rio Grande and St. Lawrence Rivers, the dream of cooperation with Tibet at the sources of the Indus, Brahmaputra and Sutlej does not seem too remote. The generous permission already granted by Sikkim and Nepal to seek and lay out snow surveys courses is auspicious.

Snow-surveying is a term used to indicate the exact determination at fixed courses of the water equivalent of the winter snow cover which in the mountains of America provides 60 to 70 per cent of the annual runoff of all snow-fed streams.

These courses are short (each having about 20 measurements 50 feet apart to provide a reliable average) and are measured April 1 at the time of greatest annual accumulation of the snow or just before the melting of the snow begins. The streams or lakes fed by the snow are likewise measured in terms of acre feet or feet of rise during April-July, their period of major runoff.

The percentage of normal of the snow courses should represent the percentage of normal of the runoff of the streams. Fortunately in America the streams had been measured long years before snow-surveying was begun. In India all measurements except a few in the Punjab and on the Kosi are lacking.

Since the winter snow in the mountains in percentage of normal falls quite uniformly for distances of several miles or even over adjacent watersheds, a few snow courses should represent the seasonal percentage of the snow over wide areas. This applies also to the snow cover at various altitudes except that at the lower altitudes some snow may disappear by premature melting during the winter. For this reason snow courses are maintained at various levels to check losses and readjust the average of the various

percentages in terms of the relative area of the snow cover at each course.

This percentage represents the percentage of runoff in the river below the snow during the period of snow melt which usually covers the month of April through July. This percentage is immediately convertible into total acre feet for the period.

One correction should be watched for during April and made if possible May 1. This is the correction for deficiency or excess in precipitation that may have occurred on the snow cover during its melting and runoff, for normal precipitation is presupposed for normal runoff from the April 1 snow. This correction in the Sierra will not exceed 10 per cent of normal.

The accuracy of the forecast is usually within 10 percent of normal. For a series of 7 basins in the Central Sierra during a period of 19 years 41 of the 63 forecasts or two-thirds were within 10 per cent. Of these 27 or more than one half were within 5 per cent. The highest error was 41 per cent.

But a recent analysis of the snow-survey data on the Colorado River above Boulder Dam for the 11 years of snow-surveys revealed an accuracy on May 1 within 15 per cent of normal for the runoff of April-July into Lake Mead. This accuracy was found in every one of the 11 years. The divergence of 15 percent in place of 10 per cent is due to the relatively heavier rain occurring during runoff on the Continental Divide or Rocky Mountains than occurs in the Sierra Nevada. The U. S. Reclamation Service now feels better able to allot the present scanty storage for irrigation and power and the U. S. Army Engineers came this year to the Nevada Agricultural Experiment Station to learn forecasting in order to grant all possible flood-storage space for the building up of water reserves. The maximum capacity of Lake Mead, known popularly as Boulder Dam, is 30,000,000 acre feet.

The exact method of sampling the snow to determine its water equivalent was worked out inevitably in studying the effect of mountains and forests on the conservation of snow. Since snow is a collection of frozen vapour crystals of varying density, the overall depth of the snow cover will fail to show its water equivalent except when the snow is in actual process of melting, and even then only approximately. So a tube and cutter were finally developed that would penetrate even cornice snow of 20 to 30 feet in thickness and bring up a perfect core for measurement. All thought of melting the snow core was promptly abandoned in the cold and wind that frequently prevailed. Weighing in inches of water was immediately adopted with a special spring balance and cradle for the purpose. It was soon learned that the colder the snow and air, the easier and speedier was the sampling.

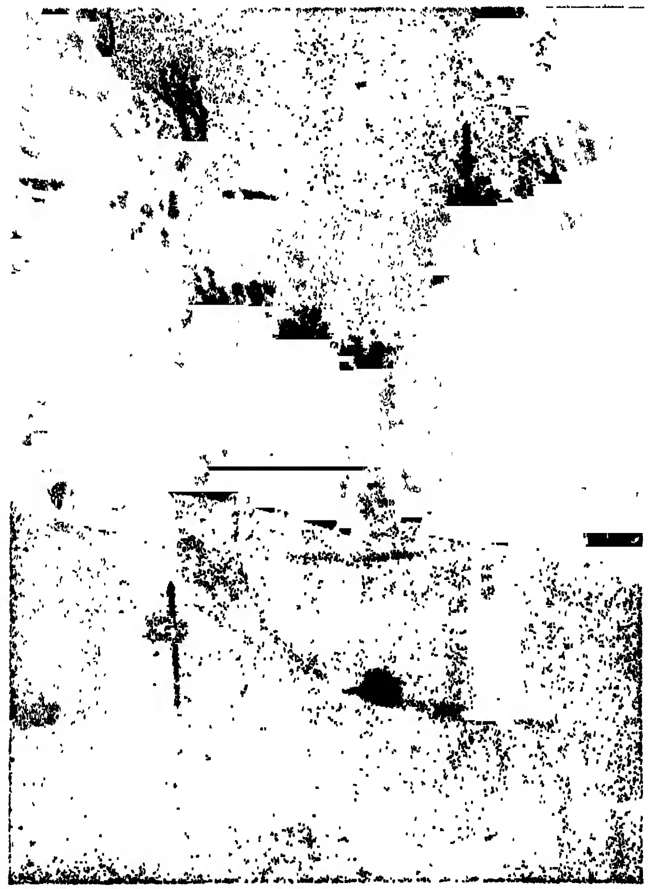


FIG. 1. The snow Sampler. It is a long tube fitted with a cutter, sufficiently long to measure deep snows.

The long snow sampler tube is now carried in lengths of 30 inches, making suitable bundles to carry in a pack with driving wrench for control and cleaning hook to insert through slots to break up the core if it should adhere in the tube. But usually the core slips out by its own weight if the sampler is inverted. Ice sheets of 1-2 inches can readily be drilled through.

The depth of the snow is determined by a scale of inches cut on the outer wall of the snow-sampler. The inches of water equivalent in the snow are shown on the dial of the spring balance which is adjusted to eliminate the weight of the sampler tube itself.

The relative density of the snow is determined by dividing the water equivalent of the snow by its depth. It may vary from that of the most delicate snowflake to that of pure ice.

Density is a much quoted term, but yields only partial information regarding the character of the snow. Its change in crystallization during accumulation and melting is a world in itself—both intricate and fascinating—to one who will lie on the snow with color dye and magnifying glass to observe it. But

this story must yield priority to the crowning story of the Himalaya snow.

Would I come to India to attempt forecasts of runoff from the Himalaya? I am sensitive to challenges and the Himalaya were the highest mountains on earth and India was now facing its future. Could the snow-survey system of American mountains be adapted to mountains twice their height and perilously hugging the heat equator?

FIG. 2. Driving the sampler in deep snow.

There were few pictures and almost no measurements of any kind available. It was a scientific adventure and none could tell whether science or adventure would come out uppermost. For the sake of the dams being planned on the Kosi and Teesta, attention was being turned to the most uncertain part of the range but fortunately to the end where trails rose through luxuriant and impenetrable forests to the yak pastures and passes of the mountain rim. For without trails hewn through forests and along rock faces, none except the primitive Tibetan could have descended and much less have ascended the streams.

But with the aid of ponies and trails and 300 miles of trekking, the snowfields were found but already in rapid retreat though the month was early April. The foot trek by J. Banerji and party up the Timur Valley in eastern Nepal had overtaken the snow but it was found relatively shallow.

Plainly the trend of the great range from Kashmir in the far northwest to Sikkim in the southeast by its gradual approach to the Equator caused a steady upward rise in the winter snowline from 7,000-8,000 feet in Kashmir to 9,000-10,000 feet in Sikkim. In Kashmir, therefore, the snow can readily be approached by highway and the "Snow-Cat" or caterpillar half-tractor can be launched on the snow for rapid transport of men and equipment to the snow courses.

But in Sikkim long trips by pony to the snow and further trek on web snowshoes or ski to shelter cabins and adjacent snow courses must be the rule. In Nepal even the trails must be improved and extended to ascend the feeders of the Kosi to probable snow courses.

To adjust the snow-surveys to the latitude, surveys in Kashmir and the Punjab should begin April 1 as in America but in Nepal and Sikkim as early as March 1.

Sikkim has now been organised and plan of surveys will be initiated in the Kosi next spring. For the Teesta there are 6 large circuits covering the eastern, northern and western parts of Sikkim. Zonal snow courses are planned in each section for 10,000, 12,000, 14,000 feet with highest zone usually at 16,000 feet. It is believed that the seasonal percentage of the snow cover here will hold good for the mountain mass above.

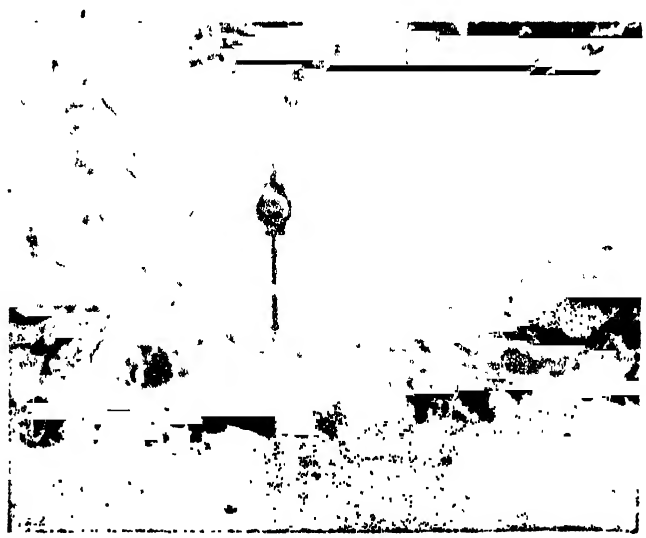


FIG. 3. Weighing a snow core nearly 20 feet long to determine water content.

The snow water was traced even higher up the streams by the diurnal fluctuations of the depth of the water (for snow melts less than 12 hours in 24 irrespective of clouds or clear sky) and by the daily increase in flow despite the upward retreat of the snow.

For the "Spitfire" plane sent up by R.A.F. April 1 brought back a vast panorama of dazzling white peaks above the clouds that veiled their base to 13,000 feet, and Everest and Kanchanjunga that towered at the head of the two valleys still looked in mid-May like marble sentinels from our trails along the Nepal-Sikkim boundary.

The lack of night freezing during our April-May trips even at 13,000 feet and the rapid melting of the snow indicated that the equatorial warmth on the southern or sunny side of the mountains might extend as high as 25,000 feet where woes from cold and wind begin for high mountaineers.

At least the snow-melt, through possibly in diminishing quantity, will continue into the period of monsoons and merge with them. Some runoff from surplus snow of heavy seasons and certainly the fairly steady contribution of ice long stored in glaciers will still be present in the autumn.

The streams must be measured in order to interpret their flow but their continuous cascades make this a special problem for the engineer. Quiet water and lakes are scant.

The present season by every indication is dry. Perhaps it is better so, for our search for snow has been more painstaking. More potential snow will come in due time. Meanwhile Everest and Kanchanjunga with their glaciers will steady the flow. But I wonder how much? Research and adventure in the Himalaya have only just begun.

THE PATEL PLAN AND THE EXPANSION OF THE A. I. R.

RAMA KRISHTNA VEPA

"THE Radio in this Country", said Sardar Patel in a press announcement indicating the future expansion of Broadcasting, "is becoming more and more popular, as it should be". An optimistic estimate it is when one remembers how slowly license figures have crept up since the A. I. R. came into existence from a 50,000 in 1937, it is barely four times that figure today; comparing it with the 450 sets per thousand of the population in U. S. A., 187 in Great Britain, it is sad to realise that a thousand Indians possess only ⅔rd of a set between themselves—and the Sardar hoped that after the Eight-Year Expansion Programme, they would have ¾th of a set. The following table shows number of sets per thousand of population in different countries of the world.

TABLE I

Country	No. of sets in millions	Population in millions	No. of sets per thousand
U. S. A.	57	130	438
Sweden	1·5	6·5	234
Great Britain ..	9·6	51	187
Germany	15·8	88	177
France	5·2	42	124
Italy	1·6	45	35
Holland	1·5	8	190
U. S. S. R.	10·5	180	58
India	·23	380	·6

Now what is this woeful lack of "Radio-Consciousness" due to? Perhaps economic poverty is partly responsible—specially when one remembers the ridiculously high priced sets in the market but this cannot be all. Some how, even in homes which can afford it, Radio is looked upon as little more than a luxury or a fashionable piece of furniture. The average cost of a Radio Unit (taking into account the luxurious Radio grams and consoles) in U. S. A. is estimated to be Rs. 160—while in India even the flimsiest superhet and nothing else is available in India, is little less than Rs. 400 and when one thinks of an average Indian as being 20 times poorer than an average American, is it surprising that Radio is a hopelessly uneconomic proposition to the vast majority in this country.

SOLUTIONS

The only solution would be the production of Indian made cheap sets—straight and superhet—durable for the tropical conditions. An expert has estimated that it is possible to produce in India, a 'luxury' valve all-wave superhet for Rs. 125 and a cheap straight set for Rs. 251.

Costs can be brought down enormously using methods employed by Nazi Germany, for the production of "People's sets" (Volksemfanger)—a two tube regenerative detector with an electromagnetic speaker. Individual components were produced by 28 different companies; and the final assembly was done by Telefunkens. Prices were eliminated and the sets priced at 35 marks (approx. Rs. 12) sold 3 million in five years. In the U. S. S. R., even more revolutionary means were employed in the "Rediffusion" system, where giant receiving stations catch the programme and radiate it on the local mains. Individual consumers have only a simple loudspeaker, plugged to the mains—a cheap system for the rural listeners, but with obvious limitations for more sophisticated urban tastes.

Problems of the A. I. R. Chain

The essential prerequisite would seem to be more transmitters. The straight set is at present useless in India where, 13 transmitters have the ambitious coverage area of 4 5 million sq. K.M. A straight set can only pull in a single station, in very restricted urban locations (right round the actual transmitter site) where however, tastes would be more cosmopolitan, and listeners would generally prefer to go on for a superhet, offering greater choice of entertainment. That is why one views with scepticism, the attempts of well known Indian industrialists to capture the market with straight sets priced at nearly Rs. 100 where obviously the conditions for their success do not exist.

A stage seems to have been reached when more transmitters for the A. I. R. seems to be essential if broadcasting is to have any future in this country. It is surprising that a country of 400 millions should have only 13 transmitters, (remember the 600 transmitters of U. S. A.) and that except for the initial outlay of 40 lakhs in 1937 for the establishment of the A. I. R., no considerable amount has since been spent on any major project if one except the Far Eastern Service, which strictly must be considered as part of the Counter Propaganda Directorate.

The small number of transmitters has affected broadcasting in many other ways. In a country like India with a diversity of languages, each with its own cultural traditions, all having a common strand of affinity, it is true, but individual enough to assert themselves, the few transmitters are unable to cater to areas widely differing in language, tastes, and consequently have been reduced, in reconciling various interests, to in the words of humorous critic—mere towers of Babel. Madras to quote a glaring example, has the unenviable duty to cater to 4 major language groups—Tamil, Telugu, Canarese, and Malayalam ; while Bombay's task is no less onerous, having to satisfy Maharashtrian, Gujerathi, and Hindustani listeners. And there are many provinces—Orissa, Assam, Sind, C. P. which have no station at all!

Planned Expansion

This can be alleviated by a planned expansion of the A. I. R., while in the last analysis, larger problems of national poverty and linguistic jealousies can be solved only by politicians and constitutional experts. With such an expansion, there is no reason why a target figure of 25 sets per thousand of the population should not be aimed at which would mean 10 million sets instead of the half million figure of the Sardar. So in U. S. A., where Radio is a billion dollar industry employing nearly a million men, India offers a rich market any potential manufacturer, who can supply the right type of set and do it cheap. Further with the spoken word reaching millions of homes, broadcasting would be integrated into the general pattern of our national life ; and together with the motion picture, might well be the great cultural unifying force that will bring the warring strains of our political and social thought to a closer understanding of each other.

But the expansion should be planned carefully and on a scientific basis, all the factors peculiar to the country being given careful consideration. Thus for instance, one should in India, remember the severe tropical interferences, the long distances, the great language groups and diversity of tastes between the urban and rural listeners. Though, comparisons are apt to be dangerous, it can be said that a certain degree of similarity exists between conditions in this country and those in U. S. S. R. a decade or two back. Here again are vast tracts and backward masses to be brought to a minimum standard of living in the shortest conceivable time ; here again, as in the U. S. S. R., broadcasting is not merely an economic enterprise, but has to be at once both an entertainment and education.

The All India Radio, had for its policy, in the words of the official report "to provide a basic short wave service in order to give at least a second grade service, to the whole of India, and then to supplement this service with a first grade medium wave service at important centres" and the latter to be expanded as more funds became available. An admirable statement of policy, but only the little proviso in the end proved disastrous for in the last ten years, in spite of crores spent on killing and the huge sterling credit collected with U. K.—none became available to expand a life line of national well being—a pathetic commentary, if any were in fact needed, on the muddled thinking of a bureaucratic government.

The New Announcement

It is therefore a welcome announcement the new broadcasting chief has made with several months of assumption of office that in the next 8 years, non-recurring expenditure of 357 lakhs would be spent in the expansion of the A. I. R. and make it a truly national service. At long last, things do seem to be moving in the right direction in New Delhi—thanks to the Congress "sledge hammer"—the Sardar.

Let us first tabulate the existing chain of A. I. R. stations with their powers, and also the proposed expansion for a rapid glance.

Before discussing the projected scheme it is desirable to sketch briefly an outline of a possible broadcasting network to serve the people effectively and the new proposals can then be examined in that light.

TABLE 2

EXISTING AND PROPOSED ADDITIONS TO THE A. I. R. (TRANSMITTERS OUTSIDE THE A. I. R. GROUP ARE OMITTED) UNDER CONSTRUCTION

Existing		Proposed additions			
Station	Power K.W.	Station	Power K.W.	Station	Power K.W.
1. *Short Wave*		1. *Short Wave*		Karachi, Nagpur, Bezwada, Cuttack, Ahmedabad, Dharwar, Calicut, Gauhati (or Shillong), Allahabad, each ...	20 K.W.
Delhi II	10	Nil			
Delhi III	5				
Delhi (far Eastern Service)	100	2. *Medium Wave*			
	100	Bombay, Calcutta, Madras, Delhi, Allahabad for urban programmes, two each	of high power		
	10				
	7·5				
	7·5				
Calcutta, Bombay, Madras, each	10	Bombay, Calcutta, Madras—for rural programmes, each	20		
2. *Medium Wave*					
Delhi I	20				
Calcutta, Bombay, each	1·5				
Madras, Peshawar, each	·25				
Lahore, Lucknow, Dacca, Trichy, Patna, each ..	5				

National Short Wave Chain

It seems desirable in view of the long distances and the vastness of the country to retain the present short wave service but allocate new functions to it. Thus we might make them part of what might be designed as the "national chain" acting as a link-up of the great cities and centres of national life. Their programmes would be of a similar pattern, and of a type to infuse a sense of rational consciousness among the various linguistic groups, for instance, one way in which this can be done is to make Hindustani, the medium of the programmes radiated on these short wave transmitters, thus bringing far more effectively a sense of common language. It is unlikely that any of the present S.W. centres—Madras, Delhi, Bombay, or Calcutta—would be only provincial capitals of the future. They are all of them centres of multilingual areas, and have become largely cosmopolitan. They might develop as national cities and in any case would remain the key centres of the country. It would seem that in the rather complex political structural balance which a future Indian constitution might evolve, some such balancing factor is essential to offset the individualistic trends which regional transmitters are bound to follow.

Urban Needs

Besides the S.W. transmitters, each of these big cities should have a high power medium wave transmitter, to catch primarily to the cosmopolitan tastes of the urban population. Here also with the urban tastes practically similar everywhere, a certain similarity in the programmes will be evidenced. The bias will be predominantly on entertainment rather than education. It might also be remarked that it might well be that English would be radiated only on these urban M.W. transmitters, as both the national and regional chain would employ either Hindustani or the particular regional language.

The Regional M. W. Chain

But the nucleus of the Broadcasting service must be the "Regional" Chain of High Power medium wave transmitters, catering to the homogeneous linguistic areas attracting the vast majority of listeners with suitable location, and considerably high power, a good first grade service can be given over the entire region, and the chain should play a great part in stimulating the cultural and social life of the people. They will also act as vehicles of propaganda for the national building schemes of the provincial government and generally act as interpreters of the official policy to the public. The nucleus must be extended as more money is available—since the greater their number, the great attraction of listening, to an average straight set owner.

Overseas Service

An important feature of the organization must not however be forgotten the overseas service. With the increasing importance of the role India has to

play in Asiatic affairs, and the need for maintaining close cultural relation with her nationals abroad, the overseas service, might well become, next to the Regional chain, the most important part of A. I. R. Two factors are in our favour—one, that there is already in service a nucleus for a high power overseas service, which might be overhauled to suit the new needs, and second that the "Service area" in which India is interested is ringed round this country. Special transmissions might be beamed to South Africa, Burma, and Malaya where Indian nationals are particularly numerous.

To summarise, an effective broadcasting organization in this country, should consist of (1) a national chain of S.W. stations (2) High power M.W. stations for urban programmes, (3) a chain of Regional High power M.W. stations and (4) an effective overseas service.

The Patel Plan

Judged by the above standards, the new proposals can be said to conform to the pattern fairly satisfactorily as shown below:—(1) A chain of short wave stations at Delhi, Calcutta, Bombay and Madras, (2) High power M.W. transmitters for urban programmes 2 each at Delhi, Allahabad, Bombay, Madras and Calcutta, (2) 20 K.W. medium wave transmitters for rural programmes at Madras, Bombay and Calcutta, (4) a regional chain of M.W. transmitters at Trichy, Dacca, Lucknow, Lahore, Peshawar, Patna, Calicut, Dharwar, Bezwada, Nagpur, Ahmedabad, Cuttack, Karachi, Allahabad, Gauhati (or Shillong) and (5) a high power Far Eastern Service.

Items (1) and (5) and partly (4) are the existing facilities while the remainder are proposed additions.

The allocation of functions has not been specified clearly as in the outline mentioned above, but it is reasonable to suppose that in practice they will closely approximate to it.

It is difficult however to appreciate item (3) where new extensions are proposed for rural service from Bombay, Calcutta and Madras. This is superfluous, as the regional transmitters can carry—and carry most effectively the bulk of the rural programmes. The rural service radiated from urban locations tends to be amateurist and suffers from lack of real "rural touch", besides linguistic problems will creep in again, reducing the value of such a service to practically zero. It seems undesirable to burden the urban studios with rural service, and if transmitters could be spared, new regional centres might be more profitably opened.

In fact, some such course will have to be adopted if the regional distribution is to be fair and adequate. Thus while most of the regional centres have been chosen admirably Nagpur seems to present a problem with the clash of Marathi and Hindustani interests. Rejecting the present procedure of bilingual transmissions which satisfies neither group, Nagpur might have to be given over exclusively to Maharashtrian tracts and in that case may be moved to Poona. The eastern half of C. P., *i.e.*, the Hindustani area, can be well covered by the Allahabad centre. Or perhaps, two transmitters might be operated at Nagpur, for the two language areas of the province; another alternative being to locate the "Hindustani" transmitter at Jubbulpore. In any case, an exclusive transmitter for the Marathi speaking area is an absolute necessity and the proposed one at Nagpur would hardly be able to serve that purpose unless considerably modified.

Obviously too, certain regions have been left either unrepresented or under represented, the Deccan, for example, where between the weak voices of Mysore (Akash Vani 25 K.W.) and Hyderabad ('8 K.W.?) there are large tracts which are not covered at all. And again the Bengali speaking tracts with a population of 53 millions, and the Andhra area with 26 millions, have only a single transmitter each, as do Orissa and Assam, with perhaps little more than 10 millions each. These can however be remedied only when further extensions are considered and additions to basic facilities made.

No specific mention was made of the overseas service, surprising in view of the fact that the problem of Indian nationals in South Africa, and the proceedings of the Inter-Asian Relations Conference have both focussed prominently, India's strategic position in Asia and the consequent need for such a service. The government, is itself, reported to be considering ways of strengthening the cultural ties between the overseas nationals and the mother country. Surely, one of the most effective ways in which this can be done is by a well organized broadcasting service, as the example of the B.B.C. has revealed specially during war time.

Organizational Set-up

Nothing has also been said about the future organizational set-up of the A. I. R. which originally came haphazardly into existence. This however did not matter so long as it remained ineffective, but now when it is sought to make it a powerful weapon, it is obviously imperative to clothe it with a more permanent constitutional structure.

There are mainly three different systems at work in the world today—(1) the private owned American system practically free of State control (though in wartime basic restrictions have been imposed by a federal agency—the F.C.C.), (2) the public owned

B.B.C. ruled by a board of Directors of which a certain proportion are government representatives and (3) the State-owned, State-Controlled Russian system where broadcasting, like in India today, is purely a State department. The A.I.R. it is true, has advisory boards but they have no powers and scarcely function. While it is impossible to discuss in detail the merits of each of the above systems, it might be wise to strike a mean between the B.B.C. and the Russian example. That government control is essential especially in the initial period of national planning none can deny ; but it is also true that the public must be associated most effectively at the highest level. Without such association, programmes will tend to be dry and lifeless and not alive to public opinion.

It seems advisable to constitute a national Radio Board composed of Government representatives and public associations to operate directly the national chain and to have supervisory authority over the Regional Radio Boards—similarly constituted with representatives of the Provincial Government and regional public bodies to whom a wide degree of autonomy on the running of the regional chain might be delegated. They should however be made responsible to the national board which in turn must be made responsible to the popular central assembly as in the case of the B.B.C. This would make it largely independent of the executive control of the government, and only subordinate to the popular will as expressed in the Assembly. Each of the Regional Boards might similarly be made responsible to the Provincial Assemblies, but it seems undesirable to have such a duality of authority leading to friction. The ultimate authority must be vested only in the national board who will take its mandate direct from the Central Assembly. It might seem academic to discuss at length the constitutional aspect of the new organization but it has been found that this has, in practice, a great bearing on the type of service, which the new organization can render to the people. How important this aspect can be guaged from the fact that even after two decades of fairly successful working, the organization of the B.B.C. has not satisfied public opinion in England and efforts are still being made to improve it suitably. Especially is it important on the infancy of our national reconstruction when this potentially powerful weapon might be misused to delude the masses with creeds of fanatical hatred. It is obvious that government control might be relaxed at a later date if conditions favour such a move.

Sponsored Programmes

The importance of "sponsored programmes" is increasing specially after its successful working in America and even in Britain, though the B.B.C. has so far fought successfully to keep its "purity" unsullied a large body of opinion would like to see its policy modified, if not altered. It is not often realised by the critics of the 'sponsored programmes' that in U.S., only one third of the time is leased to them, out of which again only a twentieth or even a thirtieth is devoted to advertisement, the remainder being taken up with a top rate radio star or a prominent public man—who would otherwise be far beyond the paying capacity of the station—and for this such enormous sums are paid to the station as to make it absolutely self supporting which would mean that an American listener for allowing a business man to advertise his wares for 12 minutes (if the normal broadcasting time is taken as 12 hours) not only listens to first rate programmes but actually listens to them free. In England, it was revealed, even before the war that a big commercial interest was prepared to pay the B.B.C. a million pounds a year, for the lease of one of her 12 wave lengths an attractive proposition even for the B.B.C. with its annual income at 3½ million pounds while it is true that public utility concerns should as far as possible be kept free from "market odours", and that in India the only justification for such programmes—more money and hence more pay for the artists and the technical staff may not be forthcoming, it seems reasonable to try an experimental measure with one or two *urban* wave lengths at Bombay and Calcutta, reserving the ultimate right of checking any programme put out on the air. If it is successful, considerable reduction or even complete abolition of license fees would be a welcome prospect for the Indian listener ; otherwise the scheme might be scrapped and the National Board resume control over the leased wave lengths.

V. H. F. and F. M. Transmissions

There is no space here for any elaborate discussion of some new methods of Broadcast transmission, now being widely employed both in U.S. and Europe. Two may be referred to, one on the Very High Frequencies (formerly called the ultra highs and lying between 30 Mc/s—300 Mc/s *i.e.* 10 metres 1 metre) and the other employing frequency modulation—F.M., for short as opposed to the conventional methods of Amplitude modulation Very real advantages are claimed for both ; for the former freedom from static and interferences and the possibility of dual transmissions from a single transmitter, together with their limited range, make them ideally suitable for point to point communication in Police, Fire and other urban facilities. It is interesting to note that Prof. Chakravarthi, lately of Bangalore, advocates the use of these very high frequencies for

the Regional chain and estimates that seventy V.H.F. stations can be established for only 125 lakhs! F. M. is said to possess a remarkable freedom from noise giving it a fidelity over a wide frequency range; so popular has F. M. become in U. S. that many F. M. transmitters have already been installed and many more are awaiting permission from the F.C.C.—while the number of receivers fitted with gadgets for F. M. reception has been showing a steep increase in recent years. It seems highly essential that Government should take the initiative in conducting exhaustive experimental tests on these new methods, so as to utilise them if the trials prove a real success.

Research Facilities

This leads on to important subject of research facilities—the absence of any specific mention about which has been the biggest disappointment in the new announcement. The present research section of the A. I. R. is little more than farcical; and considering the enormous amounts running into millions of dollars even private organizations in the U. S. like the R. C. A., G. E. C., C. B. S., the Bell Telephones etc. are willing to spend on research programmes—and they get it back in improved products and hence increasing sales, one is a little surprised now those who have organized the A. I. R. Research section could have expected it to yield any result worthwhile. Especially in India, where private commercial interests are generally too stiff to understand the value even the commercial value of fundamental research; and there is no Radio industry of sufficient magnitude it is obligatory on the part of the Government to maintain a well equipped Research Laboratory attached to the A. I. R., if the organization is to be technically satisfactory. Till now, barring the laboratories of the Indian Institute of Science, Bangalore, and the University of Calcutta, there has been even no attempt at research in this field—and this when a host of special problems are crying for solution. To mention a few, are the problems of V.H.F. transmission, the methods of incorporating F.M. gadgets in A. M. receivers, atmospherics and man made statics, design of suitable aerial systems, insulation of materials under tropical conditions, production of cheap radio components etc. It is therefore regrettable that no bold approach to the problem of research facilities has been made; and it is a vital defect in the "Patel Plan" for research carefully conducted under proper guidance might give us just the right solution for making Radio a cheap necessity in Indian homes.

Ten years ago, Prof. Saha declared in an interview "The broad-casting service in India can be made a very fine instrument for the education of the masses and for propaganda. It will create an enormous trade and will give employment to a large number of educated young men"—that hope still remains to be fulfilled!

THE DAVID TAYLOR BASIN

S. K. GHASWALA

BOMBAY

THE David W. Taylor Model Basin, U. S. A. is the largest and the best equipped ship model testing and experimental plant in the world. Apart from its equipment, the basin building was built with precision tools and microscopic accuracy and is one of the world's most amazing structure. The plant which is operated directly under the Bureau of Ships has a highly trained and capable staff to carry out its almost unending stream of problems in fluid mechanics and fluid dynamics. Thus its research activity covers such fields as the determination of the best forms for naval vessels and aircrafts; speed, power, stability and manoeuverability of ships; problems on mine sweeping devices, paravenes and torpedoes, structural strength of cruisers and submarines and the effects of shock, vibration and underwater explosions on marine structures. During the war, it also carried out various tests in fields which had practically only indirect relations with ships or aeroplanes. Thus it carried out tests on full scale ship plates to determine their strength; on the efficacy of certain pills to relieve or prevent sea sickness; on designing the best methods of packaging supplies which were to be dropped from the air; and on the most efficient manner of mooring ships under varying conditions of wind and water currents.

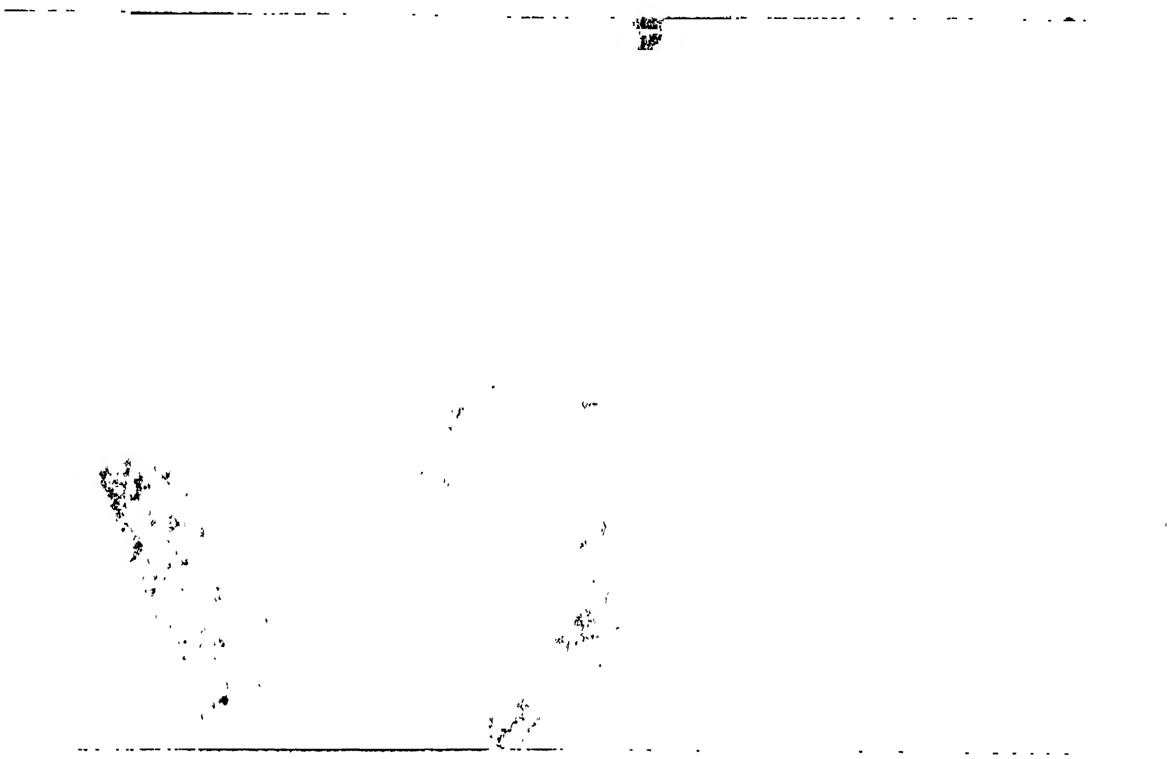
Construction and Organisation

The construction of the Basin was authorized by the U. S. Act of Congress of May 6, 1936 when that body voted a sum of $3,500,000 for the job. This new Basin was only to replace and extend the work of the original Experimental Model Basin which was

in service at the Washington Navy Yard for nearly 40 years, and which had by then comparatively obsolete equipment and practically no facilities for expansion. The work in this old Experimental Basin was for nearly 15 years under the direction of Rear Admiral David Watson Taylor, Construction Corps, U. S. Navy, (Ret) and former Chief Constructor of the Navy. To commemorate the distinguished work of Admiral Taylor, who was one of the world's foremost authorities on ships, the then Secretary of the Navy directed that the new Basin be known as "The David W. Taylor Model Basin".

nistrative Sub-division. The Technical Division has got the following sections:—Structural Mechanics, Hydromechanics, Aeromechanics, Engineering and Design. There is also a Service section dealing with Electronics, Photographic Development, Reports and Translation and Technical Service. Apart from these, the Technical Division is also responsible for retaining a Patent Adviser, eminent consultants and other Technical Advisers.

The Basin plant is located in the valley of Potomac, in Carderock, Maryland, and is about 12 miles from Washington. This place was selected as



General View of Test Section of Circulating Water Channel, looking Upstream

A TMB Planning Float is in position for test, held in place by an underwater towline which leads down to a heavy weight on the bottom of the section. The speed of the moving water when this photograph was taken was 5 knots. The channel is 22 feet wide and 9 feet deep. The truss structure at the upper end of the test section is over the downstream edge of the adjustable lip which regulates the shape of the surface as the water enters the test section. Three of the waterline viewing windows, with their external covers in place, are shown on the opposite side of the channel.

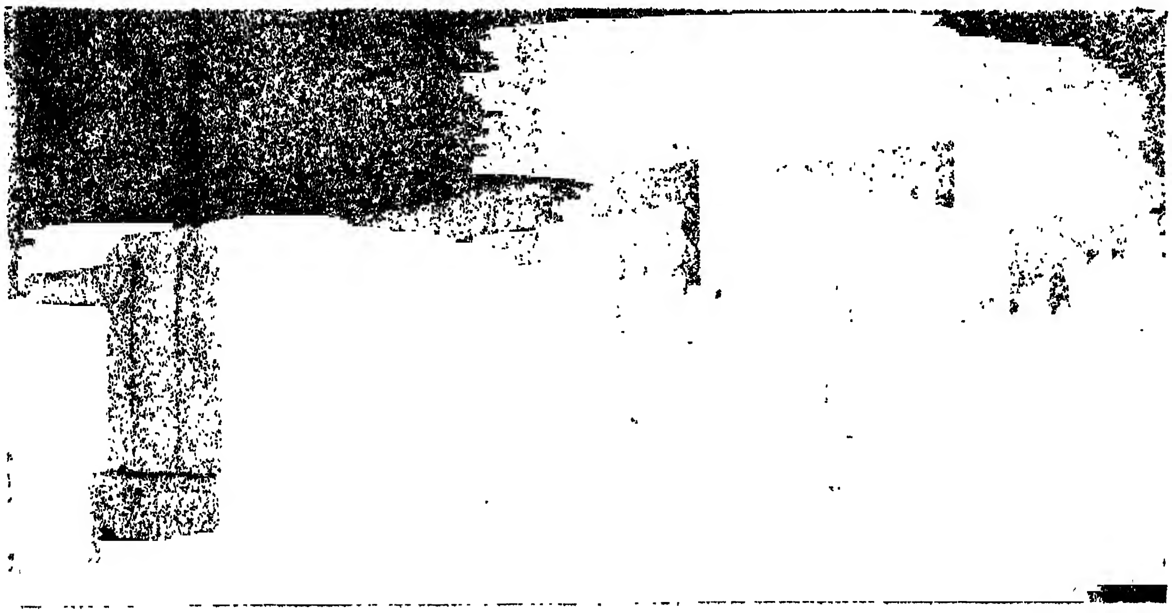
The Basin is planned with two main divisions *viz.* the Executive and the Technical. The Executive Division comprises six subdivisions *viz.* Security and Intelligence, Passive Defense, Marine Detachment, Dispensary, Production and Administration. Under Production, there operate the Machine and Model Shops, Planning and Estimating, Service and Maintenance, and Photographic and Allied Reproduction, while Personnel, Supplying, Disbursing, Accountings, Mailing and Filing operate under the Admi-

there was solid rock at the surface and an ample supply of clean fresh water. The actual design was undertaken in 1933-34 by the Bureau of Yards and Docks of the Navy Department but construction was started in September 1937, a year after the authorization by the Act of Congress. The basins were filled with water in March 1939 and the whole plant completed some 4 months later. Actual work was however started in November 1940. Before proceeding to describe in detail the various basins and their

functions, it would be quite interesting to consider some of the actual constructional details which as said at the beginning render the structure one of the most unique of its kind in the world. The testing basin is in the form of a mailing tube silvery white in appearance and has a barret arch roof, over half a mile in length. What makes this structure the most unique in existence is that it is not laid straight on the ground but very accurately follows the earth's curvature. There are several pools in this building for model ship testing, and each pool has on its two sides heavy steel rails for towing, laid with microscopic accuracy, which like the main structure itself follow the earth's curvature. Thus the 3000 feet long rails curve away from their absolute horizon by just ⅝". How these rails were levelled to curve to the radius of the earth was to anyone, but an engineer, a trick of genius. The main reason for this peculiar requirement lay in the fact that a mere ⅝" change in gradient in a length of 3000 feet would allow the gravitational force to affect the speed of the towing carriage and either accelerate or retard it. Only a limiting value of ± 0.02 of a knot change in speed would be permissible, as anything beyond this value would affect the final results on the prototype.

In view of these high precision requirements, the rails and walls of the basin building were actually laid with a microscope. The concrete was poured directly on to the granite-gneiss ledges of bedrock making the structure an exceptionally stable unit. Heavy cast-iron cushions forming chairs, were then embedded in the tops of the concrete walls and rails laid over them. The complete rail-laying operation took 18 months. Each rail weighed 55 lbs. per linear foot and was set with a lateral tolerance of ± 0.005 inch and a tolerance of only ± 0.0015 inch as far as the true horizontal level was concerned. When water was filled in the basins the rails ran absolutely parallel with the water surface which in turn was parallel with the earth's curvature.

The rails were made of special carbon-manganese steel and were laid with "scarf joints". Twenty five flame jets were travelled along the head of each rail at a set rate of 5½ inches per minute to toughen them. So great is the strength of these rails that when a 42 ton towing carriage passes over any rail, the deflection never exceeds 0.001 inch.



CIRCULATING WATER CHANNEL AND ENCLOSURE

This view shows the enlarged section of the channel, exposed to the weather, and the enclosure over the test section and the motors and pumps. In the background may be seen the west end of the Basin Building and the Turning Basin Enclosure.

DESCRIPTION OF BASINS

The whole establishment comprises 3 buildings, a main building, a basin building and a wind tunnel building.

The main building which is 871 feet by 54 feet is divided into eastern, western and central sections. The eastern section has the laboratory in which are located the 12 inch and the 24 inch jet nozzle variable pressure water tunnels capable of water speeds upto 35 knots, 30,000 pound and 600,000 pound universal static load testing machines, and a 150,000 pound

alternating load testing machine and other equipment. The variable pressure water tunnels are designed for testing model propellers and for carrying out other special hydrodynamic tests. Cavitation effects are studied in these closed duct circuit tunnels, by means of stroboscopic illumination of the propeller and the effects are recorded by high speed flash photographs, of 1/30,000 second exposure. The two large static load testing machines are used for both full size and model tests, for stress strain data, yield point and ultimate strength while the alternating load testing machine tests beams, columns, welded and riveted joints in tension and compression to determine their fatigue strength.

The western section of the building contains shops where wooden and metal models of ships and aircraft, mechanical devices, instruments, dynamometers and other special equipment are made.

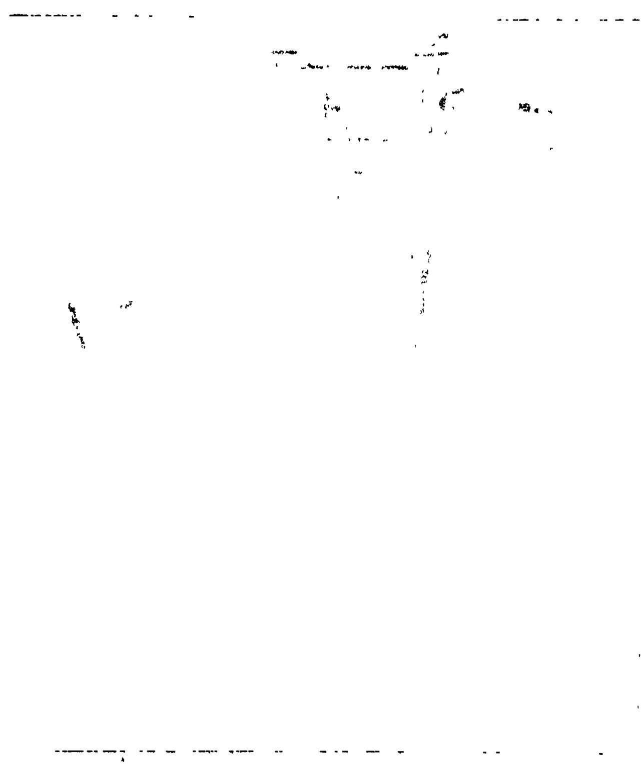
The central section houses the administrative offices, drafting, and computing rooms record storage vaults, a photographic laboratory and a library.

The basin building is 3145 feet long and runs parallel to the main building. It comprises four separate model basins each designed for a particular line of work and each following the earth's curvature. It takes 35,107,090 gallons of water to fill all the basins and other test facilities. In order to ensure good photographic work in connection with the tests, a filtering plant was constructed at the site and only filtered water is used throughout the work. Of the four separate basins, the deep water basin which is 2775 feet long, 51 feet wide and 22 feet deep is the largest of its kind in the world. Joining this large basin is a shorter shallow water basin 300 feet long, 51 feet wide and 10 feet deep. The depth here can be varied at will to represent rivers, canals, and channels of limited depth and width. In this tank models of tug-boats, barges, river craft and other shallow water vessels are tested. Forming a continuation of the shallow water basin is a J-shaped turning basin for testing the steering characteristics and maneuverability of models. Cameras 40 feet overhead record the test observations. High speed motor boat and seaplane hull models are tested in a high speed basin which is 2968 feet long, 21 feet wide and 10 feet deep.

The main building contains a basement with a small basin 142 feet long, 10 feet wide and 5½ feet deep for testing special models and carrying out unusual research problems.

The towing carriages which span the basins and work on the rails furnish the means of testing the models. The forces arising from the motion of a model through the water are measured by the dynamometer and its related recording instruments. All basins have their individual towing carriages which run on very strict specifications. So great is the accuracy with which these basins and their ancillary equipment are laid, that a man walking across the caisson dividing the deep and shallow water basins or a truck passing on the road outside would raise waves of 0·001 inch.

Underwater explosion tests are carried in a special pentagonal pond 125 feet across and 25 feet deep, dug out partly from solid rock and partly formed by built up rock embankments.



A Model of a Destroyer towed at full speed in the Deep-Water Basin under Towing Carriage 2.

In a special transparent wall tank where high speed motion pictures record the paths of models, information can be obtained on the trajectories of model bombs and torpedoes after impact with the water surface. This tank is 25 feet long, 9 feet deep and 4½ feet wide, and has ¾" thick special "tempered" glass windows on one side.

The last and the most unusual of the channels is the circulating water channel. It has an open top test section 22 feet wide and 60 feet long in which a 9 feet deep stream of water flows at a maximum speed of 10 knots. Visual and photographic observations are made through windows 4 feet by 1½ feet provided in the walls and bottom of the channel. The main advantage of this channel is that the objects undergoing tests, such as ship models, torpedo shapes, and mines, can be viewed and photographed from all sides and

that the tests can be carried on for an indefinite period without stopping as is usually the case at the end of a straight towing run.

The third and the last structure is the wind tunnel building located to the west of the main building. It contains two steel wind tunnels of closed rectangular sections 8 feet by 10 feet and equipped with 4 bladed 10 feet diameter wooden propellers. These are driven by a 100 h.p. and a 700 h.p. motor, are controlled by the Clymer system, and produce wind velocities ranging from 10 to 180 m.p.h. Airplane models upto 8 feet wing span can be tested in these wind tunnels.

Functions of Technical Division

The nerve centre of the David Taylor Model Basin is its Technical Division, and it is no wonder that herein the nucleus of the staff comprises a picked body of engineers and scientists of international reknown.

In the hydromechanics division the principal work falls within the field of ships' lines, propellers, underwater forms such as mine sweeping gears and torpedoes, design and testing of model propellers. This division also carries out full-scale special tests aboard ships of the fleet usually at the time of their trials to determine the track of a vessel under varying conditions of speed.

All problems connected with the question of the strength of a ship's structure, its vibration, the resistance of ships' structure to underwater explosion and related subjects are dealt with by the structural mechanics division. The work carried out here had its inception in the thought that if the performance of full sized naval vessels could be accurately predicted by experimental work with models in a model basin, it should equally well be possible to predict the structural behaviour of these vessels by using model technique. The original work in this Division was carried out with elementary models of hulls of ships and submarines and because of its far reaching importance and success, it now includes deck and bottom structures, turrets and their fondation and similar projects. The problems on the effects of vibration is carried out by this division both in the model basins as well as aboard the newly commissioned ships of the fleet when undergoing their first high speed runs and gun firing trials.

Problems requiring aerodynamic analysis are tackled by the aeromechanics division in co-ordination with the wind tunnel tests. The Bureau of Aeronautics of the Navy Department, and the Bureau of Ordnance together with other government departments are the main bodies for whom the tests are carried out.

In executing its highly technical work involving the measurement of infinitely small units of time, stress and motion, the Taylor Model Basin has taken a leading place in the development of special instruments, such as the high speed motion picture equipment and technique to record the details of shock and explosion, and to record super high speed events like the pressure curve of an explosion. The dissemination of authoritative technical reports all the world over, written in the most lucid and clear manner also forms one of the highlights of the Basins.*

* The writer wishes to express his indebtedness to Capt. Harold E. Saunders, U. S. N., Director, David Tayor Model Basin for furnishing him with detailed information and photographs for the preparation of this article.

THE BHORE COMMITTEE REPORT AND THEREAFTER

KALIKINKAR SENGUPTA

CALCUTTA

THE Bhore Committee's Plan* was announced more than a year and a half ago and commented upon by the Press in India, with fanfare and banner head-lines.

Free Medical Aid For All, All-Front Health Services, All-India Housing Programme, Town and Rural Planning Ministries etc. and 'No individual should fail to secure adequate medical care because of inbility to pay for it', were some of them. Short- and Long-Term programmes were published with a modicum of Social Medicine.

It was recognized for once at least, that suitable housing, sanitary surroundings, safe drinking water supply, the improvement of nutritional standards, elimination of unemployment and provision of a living wage for all workers, improvement in agricultural production and in means of communication, particularly in rural areas, were all facets of a single problem and called for urgent attention.

Earlier, in July 1945, A Five-year-Plan for the reconstruction and moral and material rehabilitation of

* Report of the Health Survey and Development Committee, Vols. 1-4, Government of India publication, 1946

7 lacs of villages in India was announced by Sir Ardeshir Dalal, the then member of the Viceroy's Executive Council in charge of the Department of Development and Planning. He said that 5-year plans had been prepared by every province in India. The total cost of these plans, excluding Bengal and N. W. F. P., came to well over Rs. 600 crores and the Bengal Plan was of the order of Rs. 150 crores. In Bengal, Mr O. M. Martin, Commissioner, Post-war Re-construction Committee, at a Press Conference held on the 20th September 1945, at the Writer's Building, explained the first instalment of a 20-year plan costing Rs. 250 crores, of which the total cost by the end of the first 5-years, was estimated at Rs. 145 crores.

We recite all these only to show that we have had schemes and plans galore, in the past, without finding fruition or execution in any concrete shape or form whatsoever.

Now let us examine for a while, how to implement the Bhore Committee's Report, at least in so far as to provide for the requisite number of medical personnel necessary for the scheme as recommended in the following table :—

Medical personnel	Present Number	Ratio to population in Br. India (300 millions)	Present ratio in U. K.	Suggested ratio in 1971 to be attained in 25 years	Number required in 1971
Doctors	47,500	1 to 6,000	1 to 1,000	1 to 2,000	185,000
Nurses	7,000	1 to 43,000	1 to 300	1 to 300	740,000
Health Visitors	750	1 to 400,000	1 to 4,770	1 to 5,000	74,000
Midwives	5,000	1 to 60,000	1 to 618	1 to 4,000 (or 1 per 100 births)	92,500
Dentists	1,000	1 to 300,000	1 to 2,700	1 to 4,000	92,500

These figures are apparently large although the Bhore Scheme is an extremely modest one, as compared with the existing conditions in the United Kingdom. For, whereas Great Britain spends for health about Rs. 60 per capita per year, the average expense for the first 10 years of the Bhore-scheme would work out at Rs. 1-14 per capita per year only. We do not propose to re-examine or recapitulate these figures here over again. We only want to point out that no country in the modern world is medically so badly served as India. The average Public Health expenditure in India, as at present, varies, in different provinces from -/3/- to -/5/- annas only per capita, per year !

The Government, in this country does not appear in the least inclined to emulate the example of other countries. They have evidently lapsed into a state of self-righteous apathy and do not exert themselves to get the better of the countervailing forces that obstruct their way. We are passing through a state of transition no doubt, yet, high priority should have been bestowed upon the problem of National Health.

Shortage of Technical Personnel

The question is how to increase and provide the medical personnel as required in the above table? By the year 1971, we have to procure at least 1,85,000 doctors of whom we have at present only 50,000, more or less.

The real bottle-neck in India's plan of post-war reconstruction and development is not so much money or material as the shortage of technical man-power. And this cannot be met by any short-cut method, but by providing for the requisite number of institutions and waiting for the necessary number of years. The ways to fight out this shortage may therefore be indicated as follows :

The available yearly output of doctors must be fully utilized and absorbed in the rural and urban areas according to the scheme of the committee. This will create a greater demand for doctors, will attract more students to the medical line and prevent congestion of medical personnel in the cities.

Means must be adopted to bring about a rapid increase in the outturn of the existing institutions. We can grow wise at Russia's instance, for her problems in 1914 were much the same or similar to those of India.

She had only 25,000 doctors, with a population of about 180 millions or about 1 doctor for more than 7,000 people, a position very similar to that of India at present. Russia's doctors were mostly of the under-graduate class, only a third of them being graduates. Between the years 1925 and 1940 they have increased their number to 1,20,000 by increasing the number of admissions into each medical institute, by training them in batches in a system of shifts as in industrial factories, and by utilizing the available clinical material in other non-teaching hospitals in the neighbourhood. This was possible, for they were in earnest and meant business.

Here there is a stupor and sloth perhaps peculiar to the constitution of a subjugated people. It is

difficult to create a dynamic 'fire-brigade' type of alertness, alive to the sense of emergency that prevails in the country, where several million lives are lost every year from preventible diseases alone. Russia increased the number of her doctors 5-fold in 15 years. It ought to be possible for India to do the same in 25. The existing institutions, which are turning out personnel of inferior qualification, namely of the licentiate rank, should be elevated forthwith to the college standard, and more colleges must be brought into existence to impart the standard of education advocated by the Bhore Committee. The existing licentiates must be given recognition by the Indian Medical Council without any further fuss. The privilege of going in for higher education, either for graduation or for post-clinical specialization must be fully thrown open to them to be utilized by them at their option but not under compulsion. The same remark applies to medical institutions that are at present engaged indifferently in imparting teaching in the so-called "other systems" of medicine. We hold that science in medicine, as in every other sphere, is one and undivided. As there is no indigenous system of Physics, nor an English, German or American system of Chemistry, Mechanics or Mathematics, so there are not so many different systems of Medicine. Drugs and medicines that can be used and utilized from these systems should be absorbed after investigation and research. But the careers of thousands of our youngmen should not be frittered away by imparting to them an inferior, incomplete and unscientific medical education, which is neither fish, nor flesh, nor good red herring! This would be a sheer wastage of men, materials and money.

With regard to the existing health-personnel, who possess qualifications not recognizable at the present moment, it would be wise to absorb them into the State services in suitable categories and, if possible, raise to the recognizable standard by suitable and supplementary evening classes while they are in service.

One must possess a standard knowledge of the basic medical sciences before one can be considered safe, if not competent, and entrusted with the handling and repair of the complicated machinery of the human body, which, unfortunately, receives here even less care and consideration than the repair of a watch or a sewing machine.

In order to encourage doctors to decongest cities and to settle in villages the Health Ministry of Russia guaranteed by enactment his status and comfort. He has been allotted a proper house and garden, and, as for his transport, he has been provided with a horse at least. His house, dispensary and hospital have been electrified, his finance improved and his hospital furnished with equipments of their own manufacture.

In our country even though the war has terminated long ago, we cannot manufacture essential drugs for want of basic chemicals and requisite machinery, for want of shipping space, as they say—although any quantity of patent and proprietary articles are being dumped herein so that India may be shorn of her slender resources and look helplessly at her more fortunate sister countries to supply her with food, clothing and medicine to hide her shame and save her life. Although 'there is little doubt that Malaria is responsible for at least 2-million deaths in India each year (Major Sinton)',—anti-malarial drugs cannot be manufactured and distributed free in adequate quantities. It is to the standing shame of the people and the Government that the control over Quinine has not yet been lifted, although transhipment has become free and easy between India, Java and other countries.

Yearly Output of Doctors

A word must be said about the step-motherly method of imparting education in our medical institutions. Merely raising the schools to the standard of college will not fulfil the purpose of getting more doctors. Rather, the reverse may be apprehended as pointed out, with good reason, by Dr B. N. Ghosh, President of the Indian Medical Association (Bengal). From the two existing colleges in Bengal, only 10% to 20% of the students can pass out yearly within the prescribed time, whereas a large number of them take from 8 to 15 years to complete their course of studies! This is all the more staggering in a country where the average longevity is about 27 years only. Some candidates after repeated failures are subjected to the penalty of reversion and have to give up their career altogether. In colleges, therefore, the number of admissions will perhaps be less than in schools and the output of doctors every year will also be less.

Consequently in Bengal, for example, if even all the 9 medical schools were converted into colleges forthwith, the output of doctors might not be increased, nay, might even be decreased by the process, unless as we said, a larger number of students were admitted and taught in double or treble shifts and there were an all-round earnestness and enthusiasm with all concerned, namely, in students, teachers, examiners and the last but not the least, the government themselves.

The Bhore Committee seems to have overlooked the necessity of laying down the minimum basic requirements of a healthy and hygienic standard of living,* for the importance of the same cannot be gain-

* Although the Bhore Committee skipped over it, the matter received attention from other workers (vide SCIENCE AND CULTURE, Vol. XI, No. 4, October 1945, p. 192)—*Ed. Sci. & Cul.*

said, in view of the fact that 75% of the diseases prevailing here, are caused by a subminimal standard of living.

The Role of the Government

It will not be out of place to examine for a while what the Government of Bengal has been doing so long. The principle so far followed by the last ministry of Bengal, has been one of reservation of seats according to religion, on the basis of minimum qualification. It has been a serious deterrent to the young and talented aspirants entering our profession. I cannot but repeat what I said in my (Presidential) address at the last Provincial Conference at Asansol:—

'It is the very negation of religious spirit to bring in religion and allow it to be exploited for reactionery political purposes and to undermine the noble aims and objects of medical education and medical relief'.

The latest of such instances of ill-advised communalism is provided by an advertizement issued recently by the Public Service Commission, Bengal, inviting applications *from Muslim candidates only*, to fill the posts of Professor of Clinical and Operative Surgery and Professor of Medical Jurisprudence in the Calcutta Medical College. These are two highly important posts and only men with specialized and teaching experience can do justice to them. It must be realized, therefore, that it is in public interest that such posts should be filled by the best available candidates without any communal consideration. The Joint Secretaries of the Bengal Provincial Branch of the Indian Medical Association have, in course of a statement, drawn pointed attention to this fact and urged the authorities not to fill these highly important posts in this manner with the sole purpose of filling them up by unsuitable members of a certain community.

Financial Implications of the Scheme

We are of definite opinion that unless the Government are prepared to spend by statutory obligation a minimum of 20 per cent of their revenues on measures of Public Health and follow the maxim of 'Health for Health's sake' and to transcending all ulterior motives of communal, religious, or sacerdotal consideration, the Bhore Committee Report will go the way of other such reports and post-war schemes and in course of time be relegated to the dust and silence of the upper archives of the Secretariat. On the other hand, with State help and public co-operation, here, as elsewhere, a phenomenal progress and development may be brought about within a reasonably short time.

In conclusion, we should only point out, what is most essential for all citizens of India to bear in mind, namely that it is a matter which brooks no delay, therefore first priority must be given to it and that a start must be made to set in motion the Man-Making-Machine for the output of the technical personnel necessary for implementing the Bhore Committee's Report; otherwise, the scheme itself will appear as preposterous as an attempt at playing Hamlet without the Prince of Denmark!

What is now required is to proceed from planning, speculation and discussion to immediate action.

VAVILOV AND THE SOVIETS

I*

PROF. R. RUGGLES GATES, the well known biologist, has written an article, on Vavilov, the famous Russian geneticist (SCIENCE AND CULTURE, *12*, 423, 1947). If it had been merely an appreciative obituary notice of Vavilov and regret had been expressed that political reasons should have led to the removal of an eminent scientist from a high position, there would have been no need of this article. Prof. Gates has however sought to make out that the Soviet State tyrannically interferes with scientific research. His actual words are "The tyranny of Sovietism can only be viewed with horror by the scientific men in countries free from Soviet rule".

In support of this serious charge Prof. Gates has noted the following facts:—

(1) Vavilov was elected an Academician of the U.S.S.R. in 1929 "but his triumph was short lived. By the end of 1931 his name ceased to appear as director" of the Institute of Applied Botany to which Lenin had appointed him in 1921.

Prof. Gates alleges that this removal of Vavilov from the position of Director occurred because his views ran counter to that of Lysenko.

Oddly enough Prof. Gates has himself noted that "Vavilov wrote to *Izvestia* and the *New York Times* in December, 1937 defending Science in the

* The Note by Prof. K. P. Chattopadhyay, Dept. of Anthropology, Calcutta University, dated 29-8-1947.

Soviets* and pointing out the great increase which had taken place in the funds for the Institute." He notes also that papers by Vavilov continued to appear and in 1937 he was made President of the Russian Geographical Society in Leningrad.

(2) Prof. Levit's Institute has been abolished because (this is what Prof. Gates says)—"a member of his staff had tested the Intelligence Quotient of Buriats in Siberia and found it lower than of some other people. This was found to be contrary to Marxian doctrine and therefore untrue". Prof. Gates seems to be unaware that Intelligence tests of Binet Simon, Terman and others are applicable only to the people living in a particular cultural environment. They do not make allowances for social, economic or political disabilities from which various classes or races suffer. Tests for people living at a lower level of material culture and who are backward in education have to be devised after a very large series of experiments. Unless this is done, the results will most likely show a lower intelligence and merely foster racial prejudice. In America (U.S.A.), Great Britain and her Dominions of course, where race prejudice is accepted by the State as normal, such a defect in scientific assessment of intelligence does not matter. But the Soviet State holds a different and more scientific and civilized attitude towards race prejudice, and condemns it.

(3) "Prof. Agol, a cytogeneticist who was Director of the Genetics Laboratory of the Ukraine Academy of Science at Kiev . . . was arrested as a Trotskyite murderer."

(4) "Prof. W. Savicki formerly Professor of Genetics at Kiev . . . reported that if he returned to Ukraine he would be executed, because he holds "views of Western World geneticists."

(5) "Last year it was reported from Russia that seven astronomers had been shot."

One should have expected an eminent biologist like Prof. Gates to be more critical of his data before rushing to the conclusions he has bruited.

The letter of Vavilov himself makes it clear that Vavilov did not consider the Soviet Government to be against scientific research or freedom of work in this field, inspite of his own removal from office as Director. The continued publication of his papers also supports this conclusion. The very great power placed in the hands of scientists in planning and research by the Soviet State is well known. It has been described by Prof. Meghnad Saha recently.* In the much admired countries of Western Europe, referred to by Prof. Gates, the scientists never held such a position before the World War II. In his own country England, until recently a fox hunting Squire had a better social position than a great scientist born of the common stock.

Prof. Gates has quoted the case of Prof. Agol and what Prof. Savicki has said and holds up his hand in horror at the arrest of a scientist as a "Trotskyite murderer". To him it seems as if such a charge by itself is preposterous. Prof. Gates cannot however plead ignorance of the organized attempts by capitalists and the States of most Western European countries, including his own, to smash up Soviet Russia. This organized conspiracy started in 1918 with the beginning of the Soviet Revolution and continues even now, with a brief halt during 1941-44 when England and America were faced with Nazi domination, unless they collaborated with the U.S.S.R. Even during the war the desire to weaken Russia led to the postponement of the opening of a second front by the Anglo-American allies.

Prof. Gates must have read in the papers of his country of the several trials of traitors and saboteurs in U.S.S.R. and therefore have known the following facts:—

(1) The well known scientist Prof. Ramzin who was then Director of the Moscow Thermo Technical Institute, and Victor Laritchev, Chairman of the Fuel Section of the State Planning Commission joined in 1928, a conspiracy organized by Russian emigré millionaires and foreign financiers of the group led by Sir Henry Deterding (Royal Dutch Shell Oil) and Sir Basil Zaharoff (British Metro Vickers), who wanted to overthrow the Soviet State. The contribution of Prof. Ramzin and his friends to this campaign was of retarding industrial development and of sabotage from inside.

In October, 1930 the plot was detected and Ramzin and Laritchev's guilt fully proved. Both were ordered to be shot; but in the case of Ramzin the sentence was commuted to ten years' imprisonment and the scientist was granted facilities for research, although kept out of any position where he might do mischief. In 1943, Prof. Ramzin was honoured by the U.S.S.R. for inventing a new type of turbogenerator and decorated with the Order of Lenin. The very merciful treatment accorded to Ramzin and grant of facilities for research does not agree in any way with the anti-Soviet conclusions drawn by Prof. Gates on the flimsy ground that some scientists were accused of murder and conspiracy against the State.

(2) From 1933, a campaign of assassination was organized by Trotsky and his followers. This was helped by the fact that in the Russian Intelligence Service the OGPU, the Chairman from 1934 (and prior to it Vice-Chairman) was the Trotskyite Henry Yagoda. Two of the medical attendants at the Kremlin were recruited by him to murder by wrong

* SCIENCE AND CULTURE, *11*, 49, 1945.

treatment and otherwise important men in the Government. Those successfully removed in this way included—

(a) Menzhinsky, the predecessor of Yagoda as head of the OGPU

(b) Kuibyshev, Chairman of the Planning Commission

(c) The world famous writer Maxim Gorky.

Among those killed by shooting was Kirov, Secretary of the Communist Party, Leningrad and by many held to be the future successor of Stalin. Big men like Zinoviev, Kamenev, Radek and others were in this conspiracy which had its links in Nazi Germany. Funds as a matter of fact came largely from that source. All these facts came out in the trials of the conspirators in 1936-37 and later.

(3) A military uprising was planned, along with organized sabotage of military and economic preparations against the attack, by Nazi Germany which was recognized as inevitable. If successful, these saboteurs would have made Russia collapse like France before the German onslaught in 1941 and thereby made possible realization of Hitler's dream of World domination.

The plot was however detected and Marshal Tukhachevsky and seven full Generals were tried and executed.

Among men engaged in sabotage were—

(a) Pyatakov, Vice Commissar of Heavy Industry.

(b) Rataichek, important official on the Central administration of the Chemical Industry.

(c) Shestov, member of the Board of Eastern and Siberian Coal Trust.

(d) Chernov, Commissar of Agriculture, U.S.S.R.

All these men were Trotskyites and drew money from German sources for their campaign of sabotage. They were finally caught, after they had done a lot of damage, and were executed. The last of these trials took place in 1938.

How real this danger from traitors inside the country was, can be realized from the following extract from what the well known American ambassador at Moscow wrote* when Germany attacked Russia:

"There was no so called 'internal aggression' in Russia co-operating with the German High Command. . . There were no Sudetan Henleins, no Slovakian Tisos, no Belgian De Grelles, no Norwegian Quislings in the Russian picture."

"The story has been told in the so-called treason or purge trials of 1937 and 1938 which I attended and listened to. In re-examining the record of these cases and also what I had written at the time I found that practically every device of German Fifth Column activity as we now know it, was disclosed and laid before the confession and testimony elicited at these trials."

These facts leave no doubt that the Soviet Government have been compelled in pure self-defence, and very justifiably, to remove politicians, scientists and technical men in high position from office and to execute some of them. These have not been acts of tyranny over scientific research or civil liberties and cannot be described as such except by a man blinded by Anti-Soviet prejudice.

How deep the tentacles of Nazi conspiracy went even in Britain, the country of Prof. Gates, may be judged from a single fact. The Churchill Government when it came into power found it necessary to arrest and place under detention a number of men in high position including Admiral Sir Harry Domville, a former chief of the Naval Intelligence.

Less than six months after the World War II ended, the Anti-Soviet campaign has started, led by Churchill in England and Truman in America. Greece and Turkey are being armed and subsidized by the Anglo American powers. Reactionary China is getting arms and dollars to prop up a feudal and dictatorial Government. The freedom fighters in Indonesia are sought to be crushed by the Anglo-Dutch combination. The reactionaries in France are offered the bait of help from America if they join this unholy alliance; already they have sought to break the Viet Nam fighters. Lastly, Franco the notorious Fascist ruler of Spain is openly favoured. Russia which lost seventy million people in the war, and had completely been destroyed by Nazi, has more villages than there are in the whole of Bengal and more dispensaries and hospitals than there are in the whole of India, is now menaced with the threat of the Atom Bomb to make her withdraw her support to democratic States.

In order that this game of bullying and blackmail may succeed it is essential that Soviet Russia should be painted black before the eyes of the world. In the early years of the Russian Revolution people were sought to be antagonized by tales of massacre of priests and nationalization of women. Now-a-days these crude stories are anachronisms. A more subtle propaganda is needed. This is best furnished by ignoring the real facts of conspiracies against Russia and her people and representing her genuine measures of self-defence as acts of tyranny.

Ours is a colonial country where we have had sufficient experience of Imperialist rule and Imperialist methods of twisting facts. We should therefore be on guard against biassed and unscientific statements of which we may expect a spate now that the Anti-Soviet campaign has started in full cry.* Only

* Joseph Davies—Mission to Moscow, New York, 1941.

* Similar articles have appeared in the *"Discovery"* published in England and *"Science"* published in U. S. A., at about the same time.

one fact need be remembered by us to enable us to evaluate such propaganda. India is a country "free from Soviet rule", and under British occupation. It is exactly here that University teachers of undoubted scholarship have been turned out of their posts in the past for holding political views which the British rulers have considered objectionable, namely that India should be free.

II*

I was disappointed to find the usual objectivity and careful accuracy of your journal SCIENCE AND CULTURE marred by some most tendencious remarks in an article by Professor Ruggles Gates in your March issue With the factual account of the work of N. I. Vavilov I have, of course, no complaint; but towards the end of the article I find some statements involving the gravest possible charges which are advanced without a vestige of evidence and which as a matter of fact are flatly contradicted by facts which are completely authenticated and quite indisputable.

I will not deal with the baseless charges about Levit's Medico-Genetical Research Institute except to ask Professor Gates what evidence he can produce. There is of course none.

With regard to Vavilov, he died in 1941, his death was reported not in 1945 but at the time in all the Soviet newspapers which printed obituaries and appreciations of his work. I have mentioned Vavilov to many Russians. They have never said to me "We do not talk about these things"; on the contrary they are furious that slanders so baseless should be spread about their country. There is not the slightest evidence that he was ever in a concentration camp, or suffered any kind of detention. It is, however, perfectly true that he ceased to be Director of the Genetics Institute of the Academy of Sciences in 1940 (not in 1931 as Professor Gates says). Messrs Hudson and Richens, whose report on the whole Genetics controversy† is accepted by Prof. Gates and by all biologists as absolutely impartial, point out that "the report of Vavilov's arrest proved to be unfounded and was retracted by the New York Times, who published at the same time a telegraph from Vavilov indicating freedom of scientific research in the Soviet Union."

Now let me turn to Professor Gates' other charges. He affirms that Professor Savicki is afraid to return to Russia because those who hold the views of Western world geneticists are executed. There is some further nonsense, again advanced without a shred of evidence, about seven astronomers being shot.

Professor Gates has read the Hudson and Richens Report on The New Genetics in the Soviet Union, published for the Imperial Bureau of Plant Breeding and Genetics by the School of Agriculture, Cambridge. This carefully documented and impartial volume is the very source from which Professor Gates obtains his facts about Lysenko, and he praises it as a masterly summary. He therefore knows but conceals the fact that Lysenko is not only criticized by Western geneticists but by Russian geneticists, and that all he, quite rightly, urges against Lysenko in his article is, according to Hudson and Richens, and many other authorities, urged just as vehemently by Sevebrooski, Zhebrak, Karpechenko, Dubinin, Profofeyeva, Ignatiev, Navaskin and Shapiro; nor has there been the slightest attempt to suppress this criticism. All these scientists express orthodox geneticists views and, as Richens says, "active work along Mendelian lines was carried on throughout this period (of official support for Lysenko) by such internationally known geneticists".

The Soviet authorities replaced Vavilov by Lysenko because in spite of Vavilov's excellent work they felt that Lysenko was a better man for the purely practical agricultural responsibilities of the post, and in view of what Hudson and Richens describe as a "contribution to biology which transcends any controversial issue" for which he was deservedly famous. This decision may well have been mistaken, but there is much evidence that the tendency today is moving in the other direction. Zhebrak, an orthodox Mendelian who has consistently and vehemently opposed Lysenko, and with complete impunity, has been made President of the Belo-Russian Academy of Sciences and head of the department of genetics at the Moscow Agricultural Academy. The Soviet Press says of him "his field is so-called classical genetics, one of the two trends in genetics being developed in the USSR. (The proponents of both schools conduct extensive investigations in the country and their works have been of much benefit to agriculture)."* There is obviously no persecution of orthodox genetics in the Soviet Union.

One can only conclude, with great regret, that in levelling charges against the Soviet Union which are contradicted by the very sources on which he asks us to rely, Professor Gates is allowing his scientific objectivity and integrity to be subordinated to political passions. In other words it is he and those who are guilty of such slanders, and not the Soviet Union, who allows his politics to corrupt his science.

* Note by Dr John Lewis, B Sc., Ph.D., Editor, *The Modern Quarterly*, London, dated 10-7-1947.

† This is the work mistakenly described as by Hudson and Richards in Prof. Gates' article. The authors are Hudson and Richens.

* "Moscow News", May 17th, 1947.

III*

I have read these communications from Dr John Lewis and Professor K. P. Chattopadhyay. They are a sad commentary on the mental gymnastics in which occasional men who claim to have scientifically trained mind will indulge, when they rush to the rescue of Communism as practised by the Soviets. They throw fairmindedness to the winds and display a degree of partisanship which shows that they are totally unwilling, or unable, to face the disagreeable facts.

Let me deal briefly with Dr Lewis first. Many of his misstatements will be obvious to anyone who rereads my original article, so I will only trouble to comment on a few, especially where additional information can be given. He speaks of the "baseless charges" regarding the treatment accorded to Levit and his Medico-Genetical Research Institute. For several years I received from Levit a yearly volume of valuable papers on human genetics. Then I received an official notice from Russia that his Institute had been merged with another all-Russian Something-or-other (I do not have the notice here) and nothing has been heard of him since, nor has any further work been received from this source. The reasons for liquidating Levit's Institute, as given in my article, were published in standard scientific journals, and there is no reason for doubting their accuracy.

It may be that Vavilov died as early as 1941. If that is true, why was his death kept so secret from the outside world that he was elected a Foreign Member of the Royal Society in 1942 and his death was first announced in the yearbook of the Royal Society in 1945, with a (?) instead of a date for his death? Zhebrak was one of those who, when asked about the circumstances of Vavilov's death, said "We do not talk about these things." If there was nothing to conceal, why did it require four years before even the Royal Society, which had elected him a Foreign Member, could learn of his decease? And why, incidentally, did Karpechenko, who was associated with him, disappear about the same time?†

There is one point on which I would alter a statement in my previous article. I said that Vavilov was a convinced Communist. In my personal talks with him he never betrayed any lack of enthusiasm for Communism; but from further information received since that article was written, I now believe that he (naturally enough in the circumstances) concealed his real opinions. The fact that he was not a convinced Communist would in itself be sufficient to account for his treatment at the hands of the Soviets. If he continued in nominal charge of the Genetics Institute until 1940, it is strange that his name ceased to appear as Director in the *Bulletin of Applied Botany, Genetics and Plant Breeding* (which he did so much to develop) at the end of 1931, as anyone can see for themselves by looking up that journal.

As regards Professor W. Savicki, I gave the page reference in *Science* where his words are quoted. If Dr Lewis does not like truth in this form his quarrel is with *Science* and not with me.

The rest of Dr Lewis' diatribe is hardly worthy of a schoolboy, and certainly not worth the pen and ink of anyone who has any desire to know the truth.

Professor Chattopadhyay attempts to instruct me in the methods of taking intelligence tests. But he goes further, and implies that my statements are based on "racial prejudice". He is evidently so inoculated with crude propaganda that his tirade is not, in my opinion, worthy of a detailed answer. I happen to have had many Indian research students and I think if they could be interrogated they would answer, to a man, that I was devoid of race prejudice so far as they were concerned. All that I have ever asked of any student is a desire for truth, enthusiasm for work and a reasonable amount of ability.

In his anxiety to whitewash the Soviets at all costs, Prof. Chattopadhyay interprets all the facts to suit himself. He ceases to have even a semblance of a scientific attitude to conditions which are well known to all the world, and cannot be disputed by any man who retains his rationality. He would no doubt either deny that Trotsky was murdered in Mexico by a Russian agent or alternatively he would attempt to justify the murder. Those who believe in assassination as a method of rule can always find an excuse for it.*

* Note by Dr R. Ruggles Gates, F.R.S., Biological Laboratories, Harvard University, U.S.A., dated 3-9-1947.

† For further interesting facts regarding "Mystery around Vavilov's death" see SCIENCE AND CULTURE, *12*, 90, 1946. Ed: *Sci. & Cul.*

[* Correspondence in the matter is closed. Ed.: *Sci. & Cul.*]

Notes and News

UNIVERSITY OF CALCUTTA

ANNUAL CONVOCATION

THE Annual Convocation of the Calcutta University for conferring degrees and medals, was held at the University College of Science and Technology at 35, Ballygunj Circular Road (Sir Taraknath Palit Estates), on Friday, the 3rd October, 1947. His Excellency Sri C. Rajagopalachari, Chancellor of the University presiding.

Dr Sir Jnan Chandra Ghosh, Director, Indian Institute of Science. Bangalore, who was invited to address the convocation, made a strong plea for maintaining the cultural unity of Bengal. (A fuller account of Dr Ghosh's address is published elsewhere in this issue).

Stressing the importance of imparting education through the medium of the vernacular, the Chancellor said that they were all agreed that Bengali should be the medium of instruction in Calcutta University. This decision was taken 27 years ago but it had not yet been fully acted upon and English still continued to be the medium of instruction in certain cases. It was very hard to change the medium of instruction all at once but they have to start from the beginning. He urged all the 24 universities in India, to agree to the mother tongue of their respective areas as the medium of instruction English should be taught as a second language and given the importance it deserved.

Addressing the graduates, the Chancellor said that their education today was not that of a slave. Their education was now directed towards equipping them as full-fledged citizens of free India. They must utilize their equipment for the benefit of their country. "Our country is passing through a great trial and wherever you go you must carry with you the mission of trust, goodwill and tolerance, not bellicosity which is a sign of incompetence, fear and suspicion."

Tracing the history of the foundation and growth of the University during the last 90 years, the Vice-chancellor (Prof. P. N. Banerji) referred to the serious curtailment in the jurisdiction of the university and the consequent decline in its revenues. Born on the 24th January 1857, the university then had its jurisdiction over the whole of Northern India including Panjab, Nizam's territories and Burma. The birth of The Panjab and the Allahabad Universities in 1882 and 1887 respectively stripped off a considerable area, leaving a territorial jurisdiction over Bengal, Bihar, Burma, the Central Provinces, Chota Nagpur, Orissa, the Central India Agency, Kashmir and parts of Oudh and The Panjab. Bihar and Orissa, Burma, and the Central Provinces separated from Calcutta in 1917, 1920, and 1923 respectively In addition Bengal itself had a second university *viz.*, Dacca in 1921 and the partition of Bengal with the dawn of independence, involves a further shrinkage in the university's jurisdiction, involving a loss of two-thirds of our High Schools and half of our Colleges, with a nett loss of revenue estimated between eight to eleven-half lakh of rupees.

Reviewing the life of the University during the last year, the Vice-Chancellor pointed out that on the 15th August last the University had on its rolls 1,130 and 411 students in the post-graduate classes in Arts and Science respectively ; 1,500 in the Law and Teaching departments ; with 60,000 students reading in 121 constituent Colleges and 5,00,000 students in the 2,300 High Schools. The University examined 92,000 candidates for the various examinations during the year under review.

Continuing the Vice-Chancellor, referred to the rich endowments in the university to the extent of one crore and fifty lakhs of rupees, yielding an annual income of Rs. 4,20,000, earmarked for specific purposes. During the year under review, the university received a donation of Rs. 30,000 and Rs. 25,000 from Ramcharan Mitra and R. C. Nopany respectively ; Rs. 30,000 from Sarat Chandra Chatterjee Memorial Fund Committee for instituting a lecturership ; Mr. J. M. Sen's gift of his ancestral dwelling house valued at Rs. 80,000 and Dr N. R. Dhar's donation of Rs. 1,19,000 bringing up the endowment to Rs. 2,00,000 for the foundation of a chair in Agricultural Chemistry in memory of Acharyya P. C. Ray. The biggest benefaction received by the university so far is a sum of Rs. 60,00,000 from the Indian Jute Mills Association for a Jute Technological Institute. A scholarship of Rs. 250/- P. M. is further offered by them for researches in Applied Physics in memory of late Prof. P. N. Ghosh. The Government of India made a grant of Rs. 2,50,000 for the Social Welfare (Labour) Institute in Calcutta. The Government further sent 68 officers from 32 different places all over India for training. The Government of India further paid a non-recurring grant of Rs. 70,000 for researches in

Nuclear Physics under Prof. M. N. Saha and agreed to pay a sum of Rs. 40,000 annually for the purpose. The recommendation of the 'Geological Education Committee' for a subvention to this university for a chair in Geology has been accepted by the Government.

Concluding the Vice-chancellor said: the system of education of the future would be guided largely by the province's relation with the State. The University would have to be allied more closely with commerce and industry. It would have to expound and develop its cultural heritage of the past and to harness its efforts to the task of national reconstruction for driving illiteracy and making the life more happy and prosperous.

5553 new graduates were admitted to the different degrees as against 4566 in the preceding year, including S. N. Bagchi (*Chemistry*), N. K. Brahmachari (*Chemistry*), R. G. Chattopadhya (*Chemistry*), N. K. Datta (*Chemistry*), A. K. Sen Gupta (*Applied Chemistry*), S. D. Chattopadhyaya (*Physics*), A. K. Saha (*Physics*), M. K. Sinha (*Physics*), B. S. Bhimachar (*Zoology*) who were admitted to the degree of *doctor of science* in the subject mentioned against their name. H. G. Biswas (*Chemistry*) was admitted to the new degree of *doctor of philosophy* (D.Phil.); D. G. Mitra to the degree of *doctor of science* (*Public Health*); and A. K. Ray Chaudhuri to the degree of *doctor of medicine*.

Coates Gold Medal for notable contribution in medical science was awarded to Dr S. N. Banerji and Dr S. K. Basu.

Nagarjun Gold Medal (named after the great Indian chemist, was awarded to N. K. Datta for best research work in chemistry in 1944 and *Sir Asutosh Mookerjee Gold Medal* to A. K. Chakravorti for best research work in Botany in 1945.

WORLD FEDERATION OF SCIENTIFIC WORKERS

THE Federation has issued a small informative booklet about its activities. Prof. F. Joliot-Curie, the President of the Federation, has written the introduction and Prof. J. D. Bernal has contributed a short article. The book is a very handy reference for the workers in different countries. It has also been issued in French besides English, which are the two working languages of the Federation. Paris has been chosen for their head office owing to the presence there of the headquarters of several world organizations with similar objects, particularly the UNESCO. Of the two Secretaries, Dr P. Bonet-Maury is in Paris and Mr J. G. Crowther is supervising the Federation's work from London until it is possible for him to transfer to Paris. Special donations and funds are wanted besides membership contribution of 1½ per cent of collection of the affiliated bodies. The following national associations have already affiliated with the Federation—Canada, China, Czechoslovakia, Denmark, France, Greece, Holland, India, New Zealand, South Africa, Sweden, United Kingdom, United States. Relation with UNESCO and World Federation of Trades Unions are being negotiated for canalizing the allied activities of all these bodies into the same channel. The first public function in which the Federation has joined was the meeting in memory of Paul Langevin held in the Sorbonne. Arrangements for Rutherford Ceremony on the 10th anniversary of Rutherford's death are being made in Paris, and one meeting will be held under the auspices of the French Academy. New Zealand will be invited to send representatives to make an appropriate link with Rutherford's early life. The Federation as a preliminary step to its future progress is drawing up a charter of scientists and a statement on world food situation in its both technical and political aspects, concerned respectively with production and distribution. Lecture tours will be made by the members of the Federation to stimulate social consciousness among the scientists.

THE GERMAN ATOMIC BOMB PROJECT

THE Atomic Bomb project though first started on theoretical plane in Germany before the war, could not succeed there owing to a variety of causes. The main reasons were that the German State authorities lacked the conviction that an atom bomb could be a decisive weapon. They failed to appreciate sound scientific advice, given by their top-scientists, unlike the British and the American Governments. Many top-ranking scientists who could help in the effort were also expelled. The directors of Nazi war effort pinned their hopes in the V-weapons and the atom bomb project received little official support. The Americans and the British on the other hand made an all-out technical and industrial effort in favour of atom bomb project.

Race-theory ridden attitude of German Warlords was very detrimental towards the enlistment of science for war-effort as has been recently revealed in a book by Dr Hans Thirring entitled *Die Geschichte der Atombombe*, and further an article in the *Discovery* (August, 1947) containing the impressions of a scientist who has spent many months in Germany on scientific intelligence work for British Intelligence Objectives Sub-Committee has given a record of the corruption of science by the Nazis. Dr Thirring says that Nazi mentality divided Physics, in two categories: German Physics, of which Lenard and Stark were notorious exponents and 'Jewish Physics' which contained the advances in theoretical physics, in particular, the theory of relativity and the quantum theory. Great names in science like Planck, Laue and Heisenberg, though they were 100 per cent Germans, did not count for much, because all their work was on 'Jewish Physics'. According to Dr Thirring there was rather a scratch team of atomic physicists who were known in the scientific circles by

the nickname of the *Uranium Club*. Their researches were carried out partly in the laboratories of the Heereswaffenamt at Kamersdorf and Gatow near Berlin, partly in the Planck's Institute at Dahlem under the direction of Heisenberg. Work on atomic pile were being carried out in Hamburg, Heidelberg, Leipzig and Munich and Venice. Experiments were on a very small scale and even if these had revealed promises, the resources in technical equipment and scientific personnel placed at the disposal of these scientists would have been inadequate for a full-scale drive for production. An effective technique of gaseous diffusion of U_{235} had been worked out in the Berlin Laboratories of Siemens and Halske. In the 'piles' paraffin as moderator was substituted by heavy water as a result of theoretical investigations by Heisenberg. For this purpose, heavy water production in Norway was stepped up, but a commando raid and aerial bombing put out of action the source of this vital material for some time.

The fate of scientists under totalitarianism has been clearly brought out in the article of Bios officer noted above. German scientific work was considerable but was confused and undirected. The war lords were not imaginative enough to see the potentialities of newer discoveries and according to the whims of the different strategic chiefs, there was competition for materials, manpower, experimental facilities and the interest of the authorities. It is now clear that the guided missiles proved very weak against the offensive by 1000-bomber squads but there was all along an emphasis on the former by the Luftwaffe chiefs. In the industrial field the promise of full employment could not but encourage inefficient use of manpower and semi slave labour in the construction gangs. The 'automatic' processes employed almost as many men as a completely manual operation. It is an interesting speculation as to what extent the Germans might have been forced to mechanize industry had they not had Europe's slave gangs to man their factories". The Bios officer concluded, "*Men of science the world over are more and more rapidly seeing the criminal folly of the statement that science and politics do not mix*; to the extent that there is adopted the opposing and positive attitude that politics is the concern of the scientist because his work is the intimate stuff of politics will the world become safer, for Germans, as for anyone else." (*italics ours*)

RESEARCH ON TECHNICAL APPLICATION OF ATOMIC ENERGY

It is interesting in the above context to give a background of research work done during the war years in Germany in connection with technical application of atomic energy. A paper on the subject by Prof. W. Heisenberg appeared in *Die Naturwissenschaften*, whose translation has been published in the *Nature* (August 16, 1947). Hahn and Strassmann's discovery of the fission of uranium was made in December 1938; Joliot and his co-workers' work in the spring of 1939 made a chain reaction fundamentally possible. United States thereafter took up the matter in right earnest. In actual fact, U. S. Government funds were first used at the turn of the year 1939-40, whereas the first discussions between men of science and the American navy took place as early as March 1939. In the summer of 1939 in Germany there was only a single paper by Flügge discussing the possibility of nuclear chain reaction. While in America previous to 1939 a whole series of modern research laboratories equipped with high voltage plants and cyclotrons was springing up, in Germany there were only two laboratories at Heidelberg and Berlin-Dahlem sponsored by a private body—the Kaiser Wilhelm Gesellschaft. Each had a small high voltage set and the cyclotron at Heidelberg built entirely by private funds and mainly designed for medical investigations with radioactive isotopes in 1938 could not be tested before 1944. In view of the possibility of the advances in the line in England and the United States, Prof. Heisenberg says, the Heereswaffenamt (German Armaments department) created in September 1939 a special research group under Schumann, to examine the possibilities of the technical exploitation of atomic energy. The scientists employed were Bethe, Clusius, Dopel, Geiger, Hahn, Harteck, Joos and V. Weizsäcker. Debye had to leave the Kaiser Wilhelm Gesellschaft, because as a Dutch citizen, he could not continue to serve under a German War Department. There was a mass of work accumulated till February 1945 and during 1943-44 experiments were even made in the air-raid shelter of the Institute. The Institute was also partly evacuated to a safer place. Prof. Heisenberg says that the beginning of 1942 seemed to be the turning point in the race for the atom bomb. Both the Anglo-American effort and the German effort arrived simultaneously at very similar results; greater progress was made by the Anglo-Americans in the field of isotope separation. And United States pushed through full scale development and their first self-supporting pile was functioning as early as December 1942. In the United States the final decision had been taken earlier for the production of atom bombs, and men, money and materials were lavishly concentrated. But in Germany, the Minister of War Production after a meeting on June 1942 ruled that work was to go forward as before on a comparatively small scale and the only attainable goal on the restricted scale was the development of a uranium pile for producing nuclear energy as a prime mover. Heisenberg asserts that under an ex-

hausted industrial capacity and the worsening German conditions after the reverses in Russia in the winter of 1941-42 coupled with enemy air superiority attempts for atomic bomb could not have succeeded. He stresses that it was not until the conclusion of war with Germany that the U. S. made ready the first bomb. Germany was in haste for the immediately useful armaments, and finally, as noted in the earlier note, there was a psychological vacuum about the potentialities of the project amongst the German warlords engrossed in projects for quick actions like V-bombs. Prof. Heisenberg concludes that in this upshot one good thing was there, they were spared the decision as to whether or not they should aim at producing atomic bombs. And he hopes that the work initiated by Hahn and Strassman will have the sowings for important technical developments for peace time application in Germany again and will in due course bear fruit there.

PLAN FOR WORLD-WIDE ATOMIC RESEARCH AND DEVELOPMENT

Dr J. Robert Oppenheimer of California University presented some time ago to United Nations Atomic Energy Commission a plan for research and development of atomic energy on the basis of "complete and absolute openness". This plan has been now made public. We have seen a small review in the *Chemical and Engineering News*, (25, 1804, 1947). He has, for the present, indicated six fields of activity. In the field of fundamental research, atomic piles will supply radioactive elements. As a typical project, carbon 14, which has been found useful in research on photosynthesis, is to be obtained from a reactor. At his own University's Berkely Laboratory, Chlorella, the precursor to photosynthesis has been identified and he says that for such research of wide outlook likely to "make profound alterations in our whole way of life", the necessary quantity of radioactive isotopes should come from an atomic reactor. About fundamental physics, Dr Oppenheimer states, "The study of fundamental particles, nuclear forces, the reasons for nuclear stability, the properties of nuclear reactions . . . . bear to atomic energy about the same relation that the quantum theory does to organic chemistry." . . . The prediction of any kind of practical fruit is really beyond even my indiscretion." For production of power, Dr Oppenheimer urges concentration of all laboratories engaged for the purpose, and says that in five years usable energy will be available from the reactors. In one, certainly less than two, decade it may be possible to apply nuclear energy to certain highly critical problem of energy generation. Another field of activity is in the means of discovery of mineral deposits and in the development of methods of recovery from low grade ores. In the field of atomic explosives, the limitations and the possibilities of the high-energy explosion will bear investigation. In the field of international control, the scientific aspect should cover the use of denaturants, production of energy out of light nuclei and the detection of clandestine plants by emitted radioactivity. Dr Oppenheimer feels it desirable for the international control agency to operate a synchrotron or synchro cyclotron in order to provide a laboratory for workers late in the field. He emphasises that the development plans must not be mixed up with the field of scientific research under one single authority. Control should only be exercised in the making of explosives and in the operation of reactors using large amounts of explosive material. Dr Oppenheimer has estimated that the whole activity of atomic research and development in its flourishing condition will be able to absorb some 10 per cent of the physicists and chemists, 5 per cent of chemical engineers and from 5 to 10 per cent of mining engineers of the whole world.

FIRST BRITISH ATOMIC PILE

Britain's first atomic pile started work at the Atomic Energy Research Establishment at Harwell in the middle of last August. This pile is known as the Gleep (Graphite low energy experimental pile) and will be assisting experimental work in nuclear physics. It is a pilot plant and there is a scheme for another plant at Sellafield for producing fissile material for use in atomic energy development generally. The present pilot plant was designed largely by a New Zealand group of scientists, with the assistance of British scientists who contributed to the production of pure graphite and uranium and have also produced the instruments required for the pile. Canadian assistance was very helpful in the testing of graphite. The work has been completed in only fifteen months. A more powerful pile is under contemplation at Harwell by 1948.

RESERVOIR AVERTS NILE FLOOD

The Nile Valley is as much susceptible to floods as is the Mahanadi. In both the valleys, it is the populous lower deltaic regions which are worst sufferers. Unlike the Mahanadi, the Nile however has a number of dams to aid in the overflow irrigation practised in the country. But these dams have been utilized more for storing water during the winter rather than for flood prevention in the rainy season. It was generally believed that if water was stored

during peak floods, so much silt would be thrown down as would considerably reduce storage volume of the reservoirs.

Since 1920, a series of experiments were carried out to ascertain the silt content of the river water at different times and it was found that the silt danger was actually over-rated. The reservoirs were filled to their highest capacities during 1943 without seriously affecting the storage. There was an acute food shortage in Egypt in 1946; it was felt that maximum water should be made available for irrigating as much cultivable land as practicable and that no premature inundation should be permitted during the floods should they come untimely. But a sudden flood actually overtook the country

The hydraulic problems which thus arose were how to hold back the amount of surplus flood water that would just fill the reservoir, and how to release the main flow through the sluices in the most uniform manner. This was the least that could be done to protect the capital and the entire river system of lower Egypt The only way of ensuring the above was to allow the maximum quantity of water to be stored in the Aswan reservoir. The flood accumulated, it rose and stopped at a level which filled the reservoir completely No flood water directly entered any of the cities or inundated the fields. The highest flood in the Nile on record passed off without causing any damage!

CHINA HITS THE MARK

The Hoang Ho in China, like the Ganges in Bengal enters the sea through a number of distributaries. At one time the main flow of the river used to reach the Yellow Sea through the southern distributary. Subsequently it breached the northern bank and jumped off into the Gulf of Pe-chi-li. This catastrophic incident was accompanied by a heavy loss of life and property, and for such acts the Hoang Ho earned an evil reputation as 'China's Sorrow'. To prevent a come-back through the southern channel once again thereby repeating the disaster the old course was sealed by an embankment. But as a result of an engagement fought during the Chino-Japanese War, the dyke was destroyed. The apprehension came true. Hoang Ho again took to its former course thereby affecting 2,900,000 acres of rich wheat land, and 6,100,000 Chinese farmers. The heavy burden of silt carried by it—for which again it has earned the name Yellow River—threatened to choke the Grand Canal passing through the neighbourhood and reaching up to the Yangtze in the south.

It therefore remained a supreme concern of the Chinese people to restore the dyke as soon as possible. The U.N.R.R.A. also moved into action because of the damage caused to the wheat lands. The U.N.R.R.A., C.N.R.R.A. and the Honan Provincial Government all combined made a supreme effort to close up the breach measuring three-quarters of a mile wide. More than 27,000 workers were engaged in the task at one stage or another. The river baffled the task on four occasions when the structures were almost washed away. At last the 'orthodox Western methods' coupled with ingenious Chinese way finally closed the gap after eight years of effort thereby pushing the river once more into the Gulf of Pechili. The Chinese are also surveying the basin of the Hoang-Ho with an area of 290,000 sq. miles for multi-purpose development of the river. This will improve the livelihood of nearly one-fourth of China's people living in the area. (*China News Week*, May 1, 1947.)

INDIAN MUSEUM

The Indian Museum, Calcutta, that was closed to the public since December 23, 1941, when the city apprehended Japanese bombing re-opened in Calcutta on October 18, last. The rich, rare and irreplaceable relics and exhibits were removed to safer zones at Aligarh, Benares, Dehradun, and other educational centres of North and Central India and the Museum Buildings placed at the disposal of the military authorities, till August 1946, when the buildings were released to the Trustees of the Museum.

The Museum was founded in 1814 under the superintendence of Dr Nathaniel Wallich, at that time a surgeon to the Danish settlement at Serampore and later Superintendent, Royal Botanic Garden, Sibpur, with the collections made by the Asiatic Society of Bengal and later incorporated with those collected by Government departments. It was recognized by the Government of India as the 'National Museum' in 1862 and the collections transferred to a Board of Trustees as provided for by the 'Indian Museum Act XVII of 1866 (subsequently repealed by the 'Indian Museum Act X of 1910'). The Museum celebrated its centenary in 1914. The present museum buildings were built at a cost of Rs. 1,40,000 and opened to the public in 1878.

The Museum contains the following principal sections of exhibits: (1) *Archaeological* (Pre-historic, Gupta, Gandhara and Muslim culture galleries); (2) *Arts* (Picture and Industrial Art galleries); (3) *Geological* (Economic, Invertebrate and plant fossil, and Siwalik mammal galleries); (4) *Industrial* (Botanical galleries); (5) *Zoological* and *Ethnological* (Invertebrates, Insects, Fish, Amphibians, Reptiles, small and large Mammals and Ethnographical galleries). It is thus not only a place for educating the general public but is of great importance to students and persons engaged in original investigation in various branches of arts and sciences.

The different sections of the museum were looked after by the respective departments of the Governments of India and Bengal situated close to the museum premises, *e.g.*, the *Archaeological section* is in charge of the Superintendent, Archaeological section of the Museum ; *Arts section* under the Principal, School of Arts ; *Geological section* under the Director, Geological Survey of India ; *Industrial* under the Officer-in-charge, Industrial section of the Museum ; *Zoological and Ethnographical* under the Director, Zoological Survey of India. The Ethnographical galleries will now be under the Director, of the newly created Anthropological Survey of India, whose office is being located in the museum buildings, in the place formerly occupied by the Zoological Survey of India.

The museum has grown into eminence by the labours of the distinguished scientists, who were experts in their respective lines and who were officers of the departments mentioned above. It is therefore obvious that now that the museum is being permanently re-opened in Calcutta, the various surveys and offices connected with the museum should also be located permanently in Calcutta, unless the Government of India or the Trustees of the Museum have plans to provide the museum with its own staff of specialists, involving additional expenditure and duplication of staff.

Under the circumstances, we cannot find out the reason, why the Government of India is still delaying the re-transfer of the Zoological Survey of India from its temporary place of residence at Benares during the war. We re-iterate once again, that we cannot approve the separation of the Zoological Survey of India from the Indian Museum (See SCIENCE AND CULTURE, *11*, April, 1946, p. 544). Lt.-Col. R. B. Seymour Sewell in his 'Memorandum on the Reorganization and Expansion of the Z.S.I.', submitted to the Government of India has rightly pointed out that "The maintenance and fitting out of the Zoological galleries of the Indian museum, Calcutta, must be an important part of the work of the Zoological Survey of India. . . . ."

If it is due to the fact that there is no more space available for the Z.S.I. in the museum buildings, we suggest that in view of the fact the great role the expanded Z.S.I. will have to play in the future development of the country, the Government of India be pleased to place at the dispssal of the Z.S.I. the vacant Belvedere House at Alipore, which is not very far from the museum and its close proximity to the Zoological Gardens, Alipore, will be an additional advantage to the Survey.

The removal of any of the surveys from Calcutta will cripple the museum of its cultural and scientific advancement. We propose to write in greater details on the Z.S.I. in a subsequent issue.

The exhibits that are being displayed at present, though good in some respects, are far too less than the pre-war numbers and some of them need replacing by good examples, and new exhibits in modern lines of thought. The fish section *inter alia*, though small is good in some respects. The other sections need careful attention for improvement, specially from the point of view of keeping uniformity with the fish section. Labels should be thoroughly revised and classification brought up-to-date. For the first time directions to visitors and descriptive labels on many exhibits have been put in Bengali and Hindi in addition to English. Some useful information should also be exhaustively added to the label wherever permissible, and popular guides provided. We urge for a general and all round improvement of the museum on modern lines of thought, and the officers of the various surveys should concentrate their attention and energies in making the museum not only of pre-war standard but of more educative value to the people of free India.

SCIENCE CLUB

THE Seventh Annual General meeting of the Club was held on Sunday, the 28th September last, at 35, Ballygunj Circular Road, Calcutta, Dr M. U. Ahmed presiding.

Addressing the gathering of scientists, (in Bengali) Dr P. C. Ghosh, Chief Minister, Government of West Bengal, as the Chief Guest on the occasion, said that the scientists from now onwards must serve for the real benefit of the masses in the country; they must propagate their researches in Bengali so that the people of the province may know what the scientists were doing for their welfare. Stressing the need of imparting education through the help of mother tongue, Dr Ghosh said that the system of education which helps to educate a few, leaving the majority in darkness, cannot continue any longer. The Government of West Bengal is determined to help educating the people in Bengali and remove illiteracy within the next ten years. The scientists in their turn have to write text books in Bengali upto the M.Sc. standard in two years' time. If Japan could write scientific literature in the Japanese language, he could see no reason why this cannot be done with Bengali.

Continuing Dr Ghosh further stressed the need of technical education. India is importing annually dyes and medicines worth ten and five crores of rupees respectively. If these could be manufactured in India we could save a lot of money. He impressed upon the audience that it is a mistake to believe that the followers of Gandhism are against large-scale industry. On the contrary, they prefer such industry, if

it is utilized for the welfare of the masses and not for the exploitation of labour. We have yet to depend for the supply of machineries needed for a cloth mill and other essential apparatus from U. K., or U. S.A. We must be able to manufacture these in our own country and unless we can do so, we will not be able to stand in competition with other countries.

Dr Ghosh further expressed the opinion that it is worthwhile to invite eminent foreign scientists for training the scientific talent in our country and he deplored the practice of sending out young scholars to foreign countries for training. It would be far more profitable and practical to appoint foreign scientists of unquestionable merit, at a very high emolument and the mistake committed in the past of appointing third rate foreign scientists at a lesser salary will not be repeated hereafter.

The following were elected office-bearers for the year 1947-48: *President*: Prof. S. K Chakravorty; *Vice-Presidents*, Dr K R Sen and Mr S. P. Sen; *Treasurer*. Dr S. M Sircar; *Secretaries*: Mr S. Mukherji and Mr S K Guha.

JOURNAL OF THE SCIENCE CLUB

We are in receipt of the first issue of a quarterly journal being the mouthpiece of 'The Science Club', established in 1940 by young scientific workers, employed in Calcutta, in both academic and industrial organizations. The Club is the meeting ground for scientific, social and cultural contact amongst the members. The fact that the club is able to publish a journal is an indication of the momentum the club has achieved during this short period since its foundation and at a very critical period in the history of the country. With the dawn of independence, the scientists in the country have to make 'original' applications of foregathered knowledge, for the industry, which will enable us to eliminate foreign competition. It is with these objects that the club through the medium of its own organ, is ready now to give their best to the country. We on our part, welcome the appearance of the journal, as we believe that the very appearance of it indicate a demand for the same. And more the scientific knowledge is propagated the better it is for the country. There are articles in the journal on post-war supply of drugs and medicinal requisites, chemical industry in India, on the problem of our villages and an editorial on planning for the future. But their remains much room for improvement. Popularization of Science is our greatest need and if the journal could turn its attention to write science notes in popular language and illustrated, it would be doing a great service for the country. The Annual subscription of the journal is fixed at Rs. 7/8/- and copies may be had from the Secretary, Science Club, 22, Ramesh Mitter Road, Calcutta.

NOBEL PRIZE IN MEDICINE AND PHYSIOLOGY

Dr. Carl F. Cori and his wife Dr Gerty Cori have been awarded half of the Nobel Prize in Physiology and Medicine for 1947. Dr Corti is Professor of Pharmacy and Biochemistry, Washington University where his wife is an Associate Professor. They are both fifty years old and they met and married in 1920, while students at Prague University.

The Coris have carried out researches on carbohydrate metabolism and enzymes of animal tissue and determined the way in which sugar was drawn from the liver and utilized by the body.

The Coris are the third man-wife team in history to win a Nobel prize. In 1903, Pierre Curie and Marie Curie won half of the prize in Physics and in 1935, F. Joliot and I. Curie-Joliot won the full prize in Chemistry.

Dr Bernardo A. Houssay, of Buenos Aires, who has been awarded the other half for 1947, is a physiologist and is noted for his research on internal secretions, including thyroid glands and diabetes.

ANNOUNCEMENTS

Prof. M. N. Saha, President, Council of Post-graduate Teaching in Science, Calcutta University, left for Paris on November 3, last to attend an International Conference on Atomic Research to be held (in memory of the twelfth anniversary of the death of Lord Rutherford) under the presidency of Prof. A. Einstein, at the invitation of the Academy of Sciences, Paris. Prof. Saha will also visit other European countries on behalf of the Government of India with a view to get acquainted with the progress of atomic research in Europe. He is expected back by the first week of December next.

Dr M. S. Krishnan, Superintending Geologist, Geological Survey of India returned to India on October 31, last after studying the science of radioactive minerals in Canada and the U. S. A. A new section to investigate radio mineralogy will shortly be established as a separate unit of the G.S.I. in connection with the programme of atomic research in India.

Sir John Russel, Chairman of Executive Committee, Empire Journal of Experimental Agriculture, Campsfield Wood, Woodstock, Oxfordshire, U. K., invites agricultural research workers and officers concerned with developments to submit papers dealing with their work for publication in the journal stated above. Research papers and summaries of results final or interim dealing with experiments in the field,

soil problems, irrigation, meteorology, economics and education, as related to agriculture, diseases and pests of plants and animals ; crop production and agricultural botany etc. are welcome. We draw the attention of our agricultural research workers and officers concerned with research and development in agriculture to avail of this opportunity and have their works known to workers in other countries.

Dr S. C. Sirkar, D.Sc., Lecturer in Physics, Calcutta University is appointed Professor of Physics, Indian Association for the Cultivation of Science, Calcutta. A distinguished Physicist with long experience of research, Dr Sirkar, will carry on researches in Optics, including Raman Effect, at the Association. Dr S. R. Palit, D.Sc., is appointed Professor of Chemistry, Indian Association for the Cultivation of Science. Dr Palit is to organize and promote research work on High Polymers at the Association. Dr Palit was recently elected Fellow of the Royal Institute of Chemistry of Great Britain and Ireland on the merit of his published researches.

Dr K. Banerji, Mahendralal Sircar Professor of Physics, I. A. C. S. left for U. S. A. for advanced studies and is expected to return in January next.

ACKNOWLEDGEMENT

The article entitled 'Aerial Prospecting of Mineral Resources' published in the October '47 issue of Science and Culture is a translation of an article entitled 'L'avion Prospecteur Des Richesses Minieres' published in *Science et Vie*, January, 1947, for which we convey our thanks to the Editor, *Science et Vie*.

ERRATUM

In October, 1947 issue p. 154, first column, line last but one, *read* Lecturer *for* Reader.

BOOK REVIEWS

An Approach to Social Medicine—By Kershaw, J. D. Bailliere, Tindall & Cox. Pp. 329+x. Price 15*sh*.

An welcome recent trend amongst scientific writers is to consider all problems relating to human welfare in a setting of social milieu. The book under review typifies that trend in a new field, *viz.*, medicine. Traditional study of medicine concerns itself with the task of curing detectable diseases by specific procedures in the individuals who are tacitly assumed to be more or less independent, self-sufficient units in the society. In contrast to that, social medicine takes into consideration environmental influences which contribute to the prevention or furtherance of diseases in the society. Society is not merely an aggregate of individuals but a living organism of which the individuals are integral parts. It will be wrong to think, according to this point of view, that no individual can be ill in isolation. No study of prophylactic or curative methods of human diseases will be complete without an understanding of the close relation of the environment created by the society to physical and mental health. Dr Kershaw's book is an admirable attempt to give that understanding to the physician and the layman alike. His conclusions are bold and stimulating, but they are not, as he himself says, finally decisive. His manner of presenting facts and arguments, however, has the commendable feature of inspiring readers to think of the various questions raised by him. Thus the co-operation of the readers is enlisted for carrying forward the search for correct solutions beyond the pages of the book.

The first part of the book discusses the structure and the function of the society, and traces the sources of social disorders and disharmonies. His thesis is that the environment in which the individual lives is produced and determined by the society. Faults in the structure and function of the society may create unfavourable environment which in turn may produce ill-health. The seeds of conflict between social standards and biological needs are implicit in the social organization. If the individual is required to rigidly adjust himself to certain patterns of behaviour demanded by the society the consequent risk of physical and psychological injury is hard to avoid. The present-day economic system and the form of Government also cause discord, making adjustment of functional activity to current need very difficult.

In the second part of the book the author deals mainly with two problems. (*i*) Integration of medicine with human life, and (*ii*) the social problems of health. Health as defined by the author does not mean merely absence of illness but a state of optimum

functional efficiency. Diseases are to be regarded as something 'which interferes with' the sufferer's practice of living. Curing a patient means the restoration of his full functional efficiency in the society. To ensure individual health, social health has to be first safeguarded. This can be done only by paying adequate attention to the problems of food, housing, education, sex and the like. What is needed is well thought out social planning with respect to every human problem, medicine not excepting. Social changes in the ordinary course come slowly. The last war, however, has accelerated the rate of such changes so that to-day the idea of social planning in different fields is more readily acceptable to us than before.

Dr Kershaw presents the problems of health and disease in a new perspective and sets a new task before the modern readers who are to-day better equipped for successfully coping with it. They will read this book with interest and profit

S. B

The United Nations : A Guide to the New World Organization By Louis Dolivet. Pp. 144 (including appendices). Phoenix House (London), 1946.

THIS is a very helpful handbook, especially for those who are interested in the details of the United Nations administration. A large part of the book consist of the Appendices containing *(a)* the Charter, *(b)* the Statute of the International Court of Justice, and *(c)* Delegations from different countries, the names and addresses of the staff of the U. N. Organization, etc., much of the last section is liable to become out of date. The introductory chapters deal with the different branches of the Organization lucidly and are illustrated by three charts. Brevity naturally does not allow any scope for learned excursions into history on law ; but one can endorse the prefatory remarks by the Secretary-General of the United Nations, M. Trygve Lie, that this handbook "presents a highly interesting and understanding view of the organization as it now exists." On controversial issues like the use of the veto, the sanctions behind decisions, etc., the notes are fair.

B. N. B.

Writers of Today—Edited by Denis Val Baker. Pp. 169. Sidgwick & Jackson. Price 8*s*. 6*d*. net.

A SYMPOSIUM on contemporary writers to which some of the ablest critics of today contribute cannot fail to provide a few hours of pleasant and animated reading, and we strongly recommend to those who are interested in writers like Aldous Huxley, J. B. Priestley, Dorothy Sayers, T. S. Eliot and others of the modern age to refresh themselves over this excellent collection of essays edited by Mr Denis Baker. Many of these writers, *e.g.*, Huxley, Graham Greene, express in their works the disintegration, if not of Western civilization, at least of the fundamental values which the people of the West had prized, and some at least like Huxley had turned to the more mature wisdom of the East, but while alive to the former with perfect candour to this latter aspect none of the critics seems to be sufficiently alive. To refer to Huxley's pacifism or his plea for detachment without a consideration of the eastern attitude towards such things, or to discuss Eliot's reactions to the eternal problems of sin and death without any suspicion of his indebtedness to the Indian views on these, seems to us who cannot fail to be incessantly aware of this, to be somewhat inadequate. Of course such limitations are bound to exist in writers whose want of acquaintance with the sources of eastern wisdom is very great. On the other hand, writers like Priestley, Dorothy Sayers, Edith Sitwell, who are unaffected by these basic elements of life receive a more satisfactory treatment. Altogether the symposium has pleased us by the unfailing zest with which each critic reviews his author, and everywhere unexpected points are brought to light and illustrated by exact references to texts that finalise passing impressions.

D. G.

Atomic Theory for Students of Metallurgy -By William Hume-Rothery, The Institute of Metals, (Monograph and Report Series, No. 3), 1946. Demy 8 vo., Pp. viii + 286. Price 7s. 6d.

The book is written with the object of helping students who are interested in recent theoretical work on the structure and properties of metals but who owing to the lack of detailed mathematical knowledge are unable to appreciate the underlying principles. Though so written the book will be found very helpful to the honours and to the post-graduate students of physics who want to have a survey of the successful applications of wave mechanics in the many fields besides spectroscopy.

The book is divided into six parts, there being altogether thirty chapters. Part I explains in a clear and lucid way without any sacrifice of accuracy the physical principles underlying wave mechanics. The reader is introduced step by step to the ψ-wave and its interpretation, and the Schrödinger equation starting from the Bohr model of hydrogen atom and dual aspects of matter and radiation. This part could have been more appropriately called wave mechanics with-

out mathematics instead of "The General Background" as it has been done. .

In Part II the structure of the free atom is considered and Paul's principle explained. A number of cleverly drawn diagrams explain the electron density distributions of the *S*-, *p*- and the *d*-states, which prepare the student to understand the nature of directed valency (Chap. XVIII) and also impress him vividly by illustrating one of the earliest and the most fundamental achievements of wave mechanics.

From free atoms one passes on to assemblies of atoms in Part III. The author starts by explaining how by soft X-ray spectroscopy "the physicist is beginning to explore the energy characteristics of electrons in solid crystals, just as the earlier spectroscopy investigated the energy characteristics of free atoms." The various types of interatomic forces—Van der Walls force, the co-valent bonding (exchange force), the metallic linkage (resonance bonding) and the ionic or polar bond are explained and the reader is introduced to the structure of alloys—the solid solutions.

In Parts IV, V and VI the problem of the motion of electron in a metallic crystal is discussed. Part IV deals with the free electron theory or the "electron box" model of metal. This is followed by the Brillouin-zone theory of metals. The behaviour of an assembly of electrons moving in the periodic fields of crystal structure is first explained after Bloch and a simple exposition of the theory is then given. This is utilized for explaining the problem of electrical conductivity and the division of the substances into insulators, semi-conductors and electronic conductors.

Part VI, the last part, on Electrons, Atoms, Metals and Alloys is perhaps of the greatest interest to the student of metallurgy. It deals with the alkali metals, with copper, silver, and gold, with some metals of higher valency and is followed by the elements of the first long period and ends with a discussion on the magnetic properties.

Dr Hume-Rothery is a well known authority on metallurgical chemistry. The Institute of Metals has rendered a real service to the serious student of metallurgy by inducing him to prepare this monograph.

N. G.

LETTERS TO THE EDITOR

[*The Editors are not responsible for the views expressed in the letters.*]

PHOTOPERIODIC EFFECT ON *SESAMUM INDICUM* LINN

SESAMUM (*S. indicum* Linn) is one of the most important and ancient crop of India largely cultivated for the oil from seeds. About one-fourth of the world's crop is produced here. 30 types of Sesamum are cultivated in India both in *rabi* and *kharif* season.

In course of our studies on the photoperiodic effects on some of the crop plants of India, a preliminary experiment was undertaken in this laboratory on Sesamum and the results are reported here. Seeds of a late maturing Indian sesamum I.P. 29, were sown in earthenware pots on 1-6-1944. There were 4 plants in each pot and 5 pots per treatment. One of the set was exposed to short photoperiod of 10 hours from germination and the other set was allowed to grow in normal light period, which gradually increased from 13 hours 10 min. to 13 hours 28 min. and then gradually decreased to 12 hours 34 min. at the time of flowering. The plants receiving short photoperiod were removed to a dark room in the afternoon after they received 10 hours light from the morning and brought back to the field after dusk. As the plants developed, the time of initiation of buds was taken as the onset of reproductive phase, which was noted as the time of budding and the time of opening of the first flower as the time of flowering. When the majority of plants in a set were flowering the heights were recorded. The result as mean values of 20 plants per treatment are tabulated below:

*Treatment	Time of bud initiation (in days)	Time of flower initiation (in days)	Height in cm. at flowering time
Normal light (13 hrs. 28 min.—12 hrs. 34 min.)	68·1	91·6	121·8
10 hrs. light period ...	26·2	43·1	50·2

Rhind[1] found that the Burmese sesamum is a short day plant flowering earlier in short photoperiod. It is seen that like Burmese sesamum, I.P. 29 also flowers earlier when exposed to short photoperiod, the earliness in this experiment being about 42 days in budding and 48 days in flowering, the vegetative period having been reduced to half of the control plants. The plants growing in short photoperiod were also less vigorous; those grown in normal light had longer and thicker stem with larger number of branches. Short photoperiod thus induced early flowering with lesser vegetative growth in sesamum.

J. C. Sen Gupta
Nirad Kumar Sen

Botanical Laboratory,
Presidency College,
Calcutta, 10-8-1947.

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THE PROTEOLYTIC ENZYME OF THE LATEX OF *FICUS CARICA* LINN

The anthelmintic action of the latex of certain fig trees has been known to the natives of America since a long time.[1] By digesting *Ascaris lumbricoides* in a solution of the active principle, Robbins[4] traced the anthelmintic action to the presence of a strong proteolytic enzyme. Walti[5] claims to have crystallised this principle by a comparatively simple procedure. Greenberg and Winnick[6] have studied some aspects of the activation phenomenon of this enzyme.

In a preliminary communication[7], we reported that the milk coagulating enzyme of the latex of the edible fig tree could be obtained in a highly active form from the latex filtrate by solvent precipitation or salting out or freezing followed by quick drying under vacuum. The preparation was quite useful as an active junket rennet. It also formed a cheese curd of quality comparable to that prepared with animal rennet. After the ripening period, however, it was observed that the cheese from the former had a slightly bitter taste which could not be traced to the presence of any bitter principle present in the enzyme itself. Although a certain amount of proteolysis is helpful in giving the final cheese its characteristic taste and flavour, an excess is considered to be undesirable because it gives rise to hydrolysis products which impart a bitter taste and flavour to the cheese. Taste and flavour being of very great practical importance in the usefulness of the vegetable rennet, we were led to study the protease component in detail.

If the rennet preparation is dissolved in phosphate buffer at *p*H 7 and stored at 27°C for 30 hours, the milk-coagulating activity was reduced to the extent of 45 per cent. When the reaction was adjusted to *p*H 4·5, nearly 52 per cent of the protease activity was destroyed, while the milk-coagulating activity remained unimpaired. In routine cheese making practice, it was found to be useful to reduce the proteolytic activity by adopting the above procedure.

The *p*H activity curves of the protease when acting on casein, edestin, egg albumin and haemoglobin showed no definite maxima for most of the native proteins, whereas, in urea solution, the substrates gave well defined maxima at *p*H 7 to 7·5. The optimum temperature was 60 to 65°C.

This kinetics of protein digestion by the enzyme indicated that the digestion of casein in aqueous medium follows no order consistently, whereas, the digestion of urea-denatured protein is a second order reaction. Evaluation of the nature of enzyme-substrate intermediary complexes indicates that one molecule of enzyme combines with one molecule of casein and there is an apparent inhibition produced by the enzyme-substrate compound. Inhibition of activity by reaction products was in conformity with Schutz's law. The kinetics of heat inactivation indicated that the reaction was of a second order at 60-66°, and at 70°. The critical thermal increments were found to be of the same order as that reported for protein denaturation.

The effect of a variety of substances like cysteine, glutathione, ascorbic acid, HCN, H_2S, ferrocyanide, phenylhydrazine, iodine, iodoacetic acid, maleic acid, H_2O_2, and salts of mercury, copper and silver, etc., on the enzyme has been studied and has yielded interesting results relating to the nature of the enzyme. The enzyme does not clot citrated ox-blood plasma and, in this behaviour, it resembles asclepain isolated by Winnick and Greenberg[8]. The denaturation, diffusion and ultra-filtration studies show that the enzyme preparation is a mixture of proteins.

Apart from its action on real proteins like hæmoglobin, casein, edestin, fibrin and albumin, the enzyme is also found to act on gelatin, peptones and synthetic substrates like hippurylamide. Attempts at purification of the enzyme by well known adsorption techniques have shown that the enzyme is completely adsorbable at *p*H 6·5 on animal charcoal and partly on kaolin.

C. R. Krishnamurti
V. Subrahmanyan

Department of Biochemistry,
Indian Institute of Science,
Bangalore, 11-8-1947.

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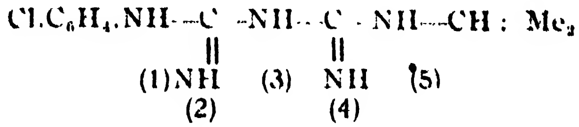
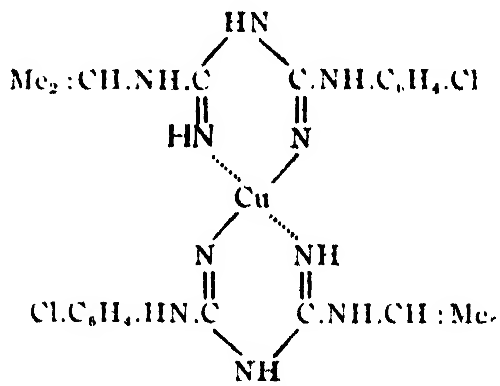
ON THE MODE OF ACTIVITY OF "PALUDRINE"

THE recent investigations leading to the synthesis of p-chloro-phenyl-*iso*-propyl biguanide-'Paludrine' base, (I) by Curd and Rose[1] has revealed the antimalarial activity in a new class of compounds. The observations of Hawking[2] tend to show that the antimalarial activity of this compound is most probably due to some other active compound formed *in vivo*. This has opened up a new field of investigation and research. Being a biguanide, the antimalarial paludrine should exist in various tautomeric forms (*cf.* Hughes[3] and Pauling[4]) ; it would be a matter of further investigation (*cf.*, Basu[5]) to see whether any particular form of the biguanide is responsible for its chemotherapeutic action.

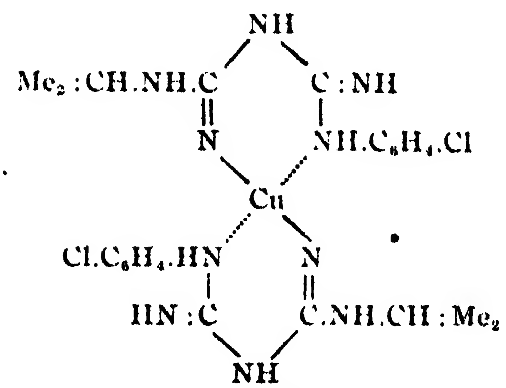
It may be noted, however, that a biguanide molecule has a tendency to form a chelate ring and readily forms metallic complex of a structure akin to porphyrin ring system. Curd and Rose[6] have suggested that it is this characteristic that might be connected with antimalarial action of 'paludrine'. It may be here added that the formation of such chelate ring with metallic atom might remove the element from the phase in which it is present in the system. It is now known that for the growth of various micro-organisms presence of certain mineral salts are necessary. If the malarial parasites require some trace elements for their metabolism, then the formation of the above type of chelate metallic derivative might deprive the parasites of their mineral requirements (*cf.*, Albert[7]). Under these circumstances the two substituents-chloro-phenyl and iso-propyl at the nitrogen atoms (1) and (5) respectively in the biguanide (I), may play a considerable role in the formation of the chelate and subsequent impartation of a physiological characteristic to the compound *in vivo*. As a matter of fact it has been already established that introduction of the *iso*-propyl group enhances the antimalarial activity in the chlorophenyl-biguanide. Curd and Rose[6] themselves have suggested that paludrine forms a copper complex of the structure (II) where the two substituents are symmetrically placed in the chelate ring. But according to the investigations that have been extensively carried out by Ray and his collaborators[8], the above type of complex should be represented by the structure (III), where co-ordination with the metal atom has occurred at N (1) and co-valence at N (4). The electro-chemical nature of the substituents at the terminal Nitrogen atoms might alter the resonance of the biguanide molecule, exert an influence in the formation of the chelate ring with trace elements like iron, copper, cobalt, zinc, and thereby, more readily deprive the malarial parasites of their metallic nutritive requirements.



(I)



(II)



(III)

On the above hypothesis, it would be of considerable interest to study the nutritional requirements of the various malarial parasites for the trace elements as well as to investigate the influence of substituents other than halogen in the phenyl biguanide molecule.. Work in the former direction is being contemplated and in the meantime various p-sulphonamido phenyl biguanides (IV) are being prepared for antimalarial study by reacting a

sulphonamide derivative (sulphanilamide, sulphathiazole, sulphadiazine) that is also known to exert an antimalarial activity, with dicyandiamide compound. The reaction may be represented as follows:

$$\mathrm{R.NH.SO_2C_6H_4NH_2 + CN.NH-C(:NH)-NHR'}$$
$$\longrightarrow \mathrm{R.NH.SO_2C_6H_4NH-\underset{\underset{NH}{\|}}{C}-NH-\underset{\underset{NH}{\|}}{C}-NHR'}$$

(IV)

where R = H, thiazole, pyrimidine ring, and R′ = H, and alkyl chain.

U. P. Basu

Bengal Immunity Research Laboratory,
Calcutta, 26-8-1947.

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ESTIMATION FROM AN INCOMPLETE SAMPLE

Sometimes in an actual survey, enumeration of all the n units of the original random sample cannot be completed, but only r units ($r<n$) are finally enumerated. Such a case may also arise indirectly, for example, in a regional or *areal* sample survey, when an estimate is required over a region of area A', which is only a part of the original region of area A over which n sample-units (or sample-points) have been located at random. The case becomes simplified if we can assume that the chance of any unit being finally enumerated is P, independently of the other units; for the *areal* sampling case, this is always so, with $P = A'/A$. If we suppose that the variate under enquiry is distributed normally with mean M, and $S.D.$ σ, then the sampling distribution of m, the mean of the incomplete sample of size r, will be given by

$$\frac{dm}{\sqrt{2\pi}\,\sigma\,(1-Q^n)}\sum_{k=1}^{n} {}_nC_k\, P^k Q^{n-k}\sqrt{K}\,exp.\left\{-\frac{k}{2\sigma^2}\left(m-M\right)^2\right\},$$

a distribution symmetrical about M, though not normal. ($Q = 1-P$).

The interval-estimation for M, or the evaluation of the fiducial limits of its estimate, can be attempted with the help of the above distribution, but the calculations will be rather cumbrous. An alternative method, however, can be devised by an extension of the usual *fiducial argument*, with which the fiducial limits of the estimates for M can be derived from the usual tables of the statistic 't', with $t = (m-M)\sqrt{r}/s$, and $d.f. = r-1$, where s^2 is the variance of the incomplete sample (*i.e.*, the "sum of squares" divided by $r-1$).

Birendranath Ghosh

Statistics Department,
Presidency College,
Calcutta, 8-9-1947.

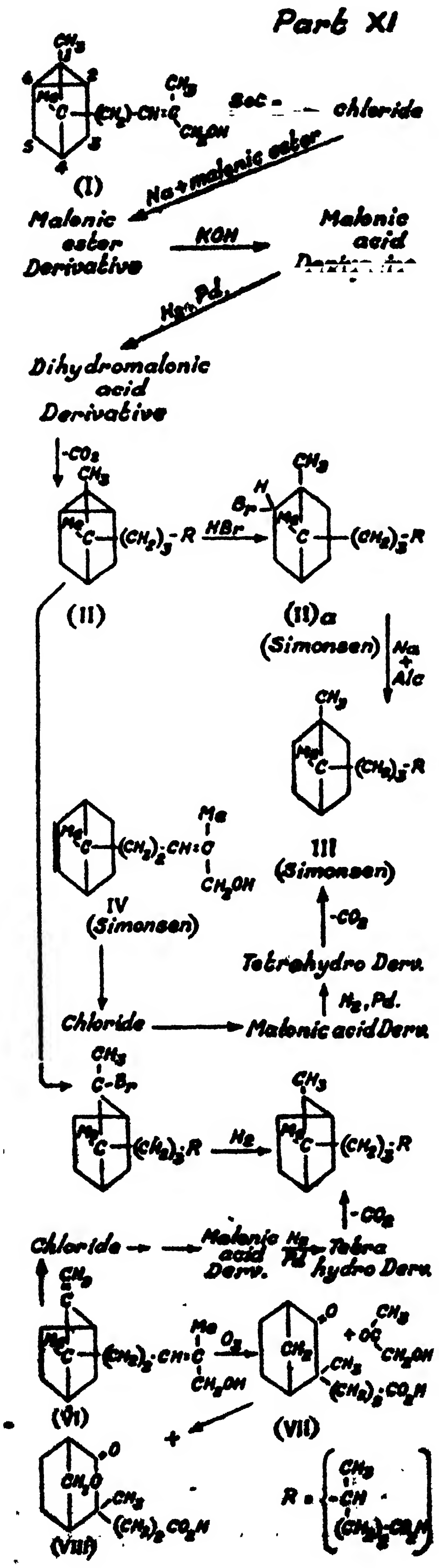
STUDIES IN THE SANTALOL SERIES

Part XI: Structure of β Santalol and β Santalene.

Simonsen[1] found that dihydro-α-santalyl acetic acid (II) obtained from α-santalol (I) on digesting with acetic acid solution of hydrobromic acid forms a hydrobromo derivative (IIa) by rupture of the cyclopropane ring. This bromo derivative on reduction with sodium and alcohol forms a tetrahydro-santalyl acetic acid which is identical with that obtained under analogous condition from β-santalol. Simonsen, keeping analogy with the decomposition of teresantalic acid[2] assumed that during the formation of hydrobromo derivative from (II) the bond between carbon atoms 2 and 6 was ruptured. He therefore suggested the formula (III) for tetrahydrosantalyl acetic acid and consequently the structure (IV) for β-santalol. It has been shown in part I of this series that with aqueous or acetic acid solution of hydrobromic acid the cyclopropane ring of α-santalol derivatives like tricyclockasantalic acid is ruptured between carbon atoms 1:2 or 1:6 so that tetrahydrosantalyl acetic acid should be represented by (V) and not (III) and consequently β-santalol by the camphene type formula (VI) and not by the bornylene type structure (IV) as suggested by Simonsen. It should be noted in this connection that neither bornylene nor any other compound having a bornylene ring is known to occur in any natural products, whereas camphene is very widely distributed in nature. The camphene type of formula (VI) as is now forwarded for β-santalol should therefore be the more probable one. This view has been confirmed by degradative experiments as well as by synthesis.

Ruzicka[3] by ozonisation of β-santalol and β-santalene rich fraction of sandalwood oil obtained products

analogous to those obtained by ozonisation of camphene[4] and bicycloekasantalic acid (see part III of this series). Pure β-santalol (b.p. 158°/5 mm.; a5780 = −76·1; unsaturation value 1·99) isolated by us has been thoroughly examined. On ozonisation in carbon tetrachloride or acetic acid the following products were obtained; camphenilonyl acetic acid (VII), b.p. 148-152°/·1 mm.; methyl ester 138-139°/5 mm.; m.p. 76°; β-(methyl-nor-campholidyl)-propionic acid (VIII), b.p. 180-186°/·1 mm.; methyl ester b.p. 132°/·1 mm., and hydroxy acetone. β-Santalol should therefore be represented by (VI). β-Santalene which gave similar products should have an analogous hydro-carbon structure.



The author's thanks are due to Prof. P. C. Guha, D.Sc., F.N.I., for his kind interest during the course of this investigation.

S. C. Bhattacharyya

Organic Chemistry Section,
Dept. of Pure & Applied Chemistry,
Indian Institute of Science, Bangalore.
21-9-1946.

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[4] Harries, *Ber.*, 43, 1432.

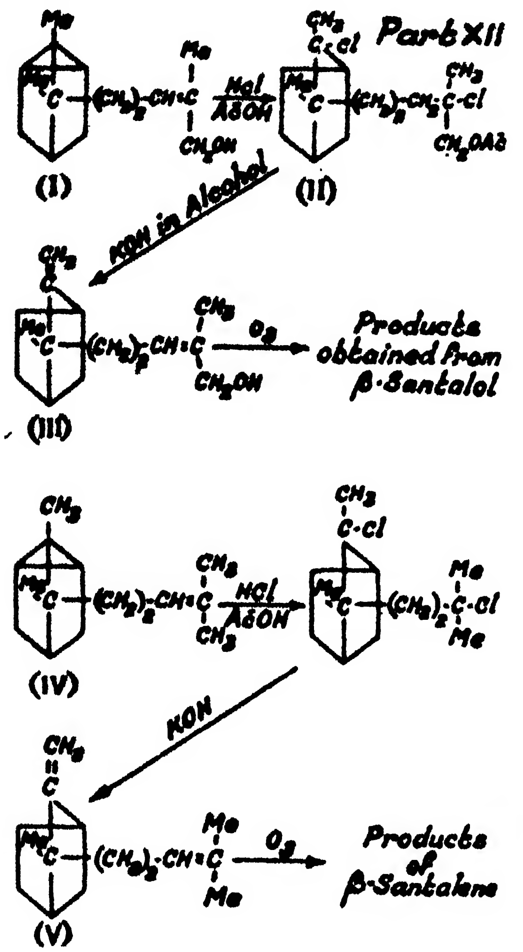
STUDIES IN THE SANTALOL SERIES

Part XII: Conversion of α-Santalol to β-Santalol and α-Santalene to β-Santalene.

α-Santalol (I) in glacial acetic acid was saturated with gaseous hydrochloric acid forming a dihydrochloro-acetate which has probably the structure (II). On hydrolysis with alcoholic potash, the hydrochloro-acetate was converted to (III). After purification through the strychnine salt of hydrogen phthalate (III) showed the following properties: b.p. 158°/5 mm.; d_4^{20}, ·9729; n^{D20}, 1·5117, unsaturation value 1·99; a5780 = −56·1. Except some variation in the value of optical rotation, all other properties were identical with those of β-santalol[1]. On ozonisation (III) furnished products which were identical with those obtained from β-santalal (see part IV of this series). Under ordinary conditions it is very difficult to separate β-santalol from α-santalol, but by this process it is possible to convert the total santalol fraction of sandalwood oil to β-santalol.

Similarly pure α-santalene, (IV) b.p. 117°/7 mm.; d_4^{20} ·9118; n_D^{20}, 1·4884; a5460 = +4·6° (see part VI of this series) or the usual santalene mixture of sandalwood oil can be converted to β-santalene (V), b.p. 125°/7 mm.; n_D^{28}, 1·4959; d_4^{28}, ·8931, unsaturation value 1·99; a546 = −39·32. On ozonisa-

tion products similar to those obtained from β-santalol were obtained.



The author's thanks are due to Prof. P. C. Guha, D.Sc., F.N.I., for his kind interest during the course of this investigation.

S. C. Bhattacharyya

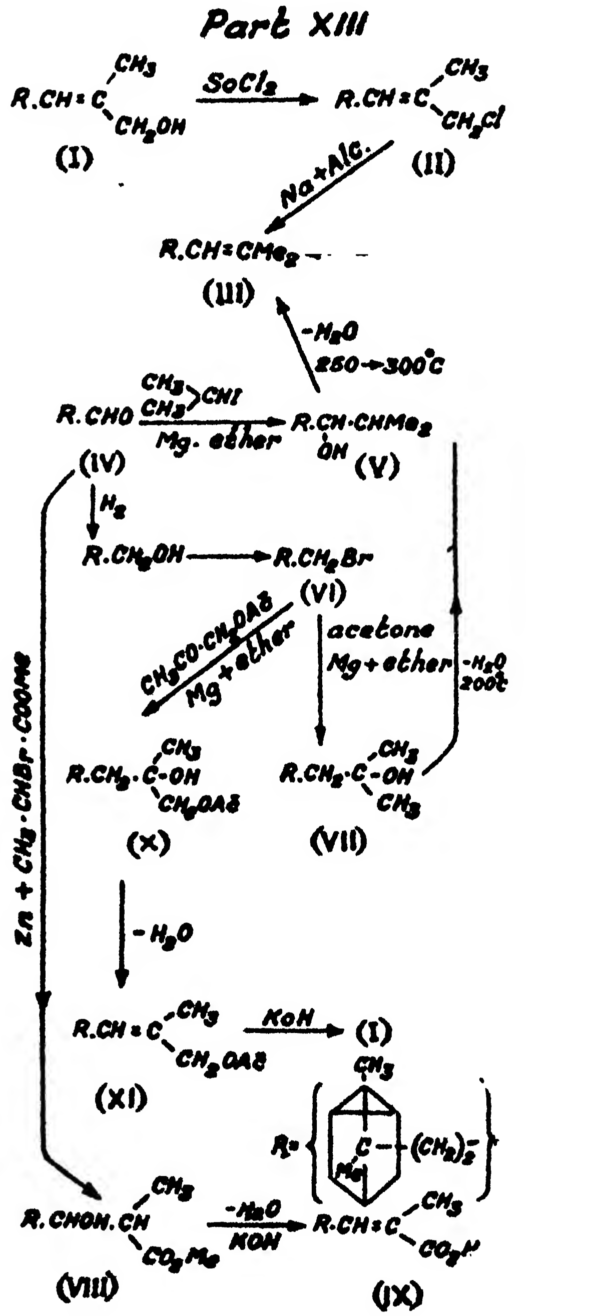
Organic Chemistry Section,
Dept. of Pure & Applied Chemistry,
Indian Institute of Science, Bangalore.
21-9-1946.

[1] Guha and Bhattacharyya, *J. Ind. Chem. Soc.*, *21*, 271, 1944.

STUDIES IN THE SANTALOL SERIES

Part XIII: Synthesis of α-Santalene Acid and a New Synthesis of α-Santalol.

Pure α-santalene cannot be isolated from the santalene fraction of sandalwood oil. When the purity of the sample reaches to about 90 per cent no further purification is possible through fractionation.[1] Pure α-santalene has now been prepared in an indirect way. Pure α-santalol (I), α5460 = +10·4°, unsaturation No. = 1·00, is converted with thionyl chloride and pyridine to the corresponding chloride (II), b.p. 136-138°/5 mm.; α5460 = +7·8. The compound (II) on reduction with sodium alcohol is converted to α-



santalene (III) purified by distillation over sodium, b.p. 114°/5 mm.; α5460 = +4·6; n^{20} 1·4884; d_4^{20}, ·9118; unsaturation No. = 1·00. On oxidation with permanganate or ozone (III) gives tricycloekasantalic acid, thus establishing its constitution. A direct synthesis of (III) has been performed as follows. Magnesium isopropyl iodide reacts with tricycloekasantalol (IV)[2] producing a secondary alcohol (V),

b.p. 160-163°/5 mm. which loses a molecule of water at 250-300°, in presence of traces of kieselgur or alumina forming (III). The Grignard compound of tricycloekasantalyl bromide (VI) reacts with acetone forming a tertiary alcohol (VII), b.p. 150-155°/5 mm., which easily loses a molecule of water at 200° giving (III). Tricycloekasantalol (IV) reacts also with zinc and α-bromo-methyl propionate to form the hydroxy ester (VIII), b.p. 165-170°/1 mm. ; the free acid easily loses a molecule of water on heating giving α-santalic acid (IX), b.p. 171-173°/1 mm.

The Grignard compound of (VI) reacts preferentially with the keto group of Acetoxy acetone forming (X), b.p. 178-183°/1 mm., which loses a molecule of water at 200° forming α-santalyl acetate (XI), b.p. 150-155°/5 mm. from which α-santalol is obtained by hydrolysis, b.p. 148°/5 mm. ; n_D^{20}, 1.5029 ; d_4^{20}, ·9780 ; stychnine salt of hydrogen phthalate, m.p. 147°.

The author's thanks are due to Prof. P. C. Guha, D.Sc., F.N.I., for his kind interest during the course of this investigation.

S. C. BHATTACHARYYA

Organic Chemistry Section,
Dept. of Pure & Applied Chemistry,
Indian Institute of Science, Bangalore.
21-9-1946.

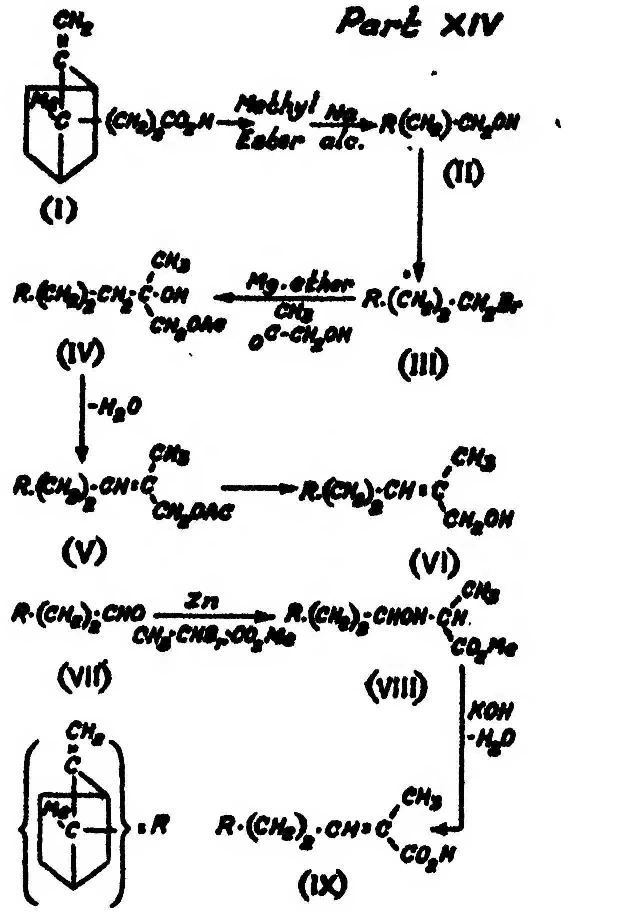
1. Guha and Bhattacharyya, *J. Ind. Chem. Soc.*, 21, 269, 1944.
2. Simonsen, *J. C. S.*, 313, 1935; Guha and Bhattacharyya, *J. Ind. Chem. Soc.*, 21, 281, 1944.

STUDIES IN THE SANTALOL SERIES

Part XIV: Synthesis of β-Santalol and β-Santalic Acid.

Methyl ester of bicycloekasantalic acid (I) on reduction with alcohol and sodium formed bicycloekasantalol (II), b.p. 132°/9 mm. The Grignard compound of the bromide (III), reacted preferentially with the ketogroup of acetoxy acetone forming the tertiary alcoholic ester (IV), b.p. 188-192°/1 m.m., which is dehydrated with acetic anhydride or by heating at 200° in presence of traces of alumina or kieselgur to form β-santalyl acetate (V), b.p. 158-162°/5 m.m. (V) on hydrolysis furnishes β-santalol (VI) which can be purified through its hydrogen phthalate, b.p. 158°/5 mm. ; d_4^{20}, ·9728 ; n_D^{20}, 1.5119, unsaturation value 1·99 ; α5780 = −72·2°. Strychine salt of hydrogen phthalate, m.p. 133°.

Bicycloekasantalol (VII), b.p. 117-119°/10 mm., on treatment with zinc and α-bromomethyl propionate forms the alcoholic ester (VIII), b.p. 175-180°/1 mm. The free acid easily loses a molecule of water forming β-santalic acid (IX) ; b.p. 181°/1 mm. ; n_D^{20}, 1.5148 ; unsaturation value 2·00.



The author's thanks are due to Prof. P. C. Guha, D.Sc., F.N.I., for his kind interest during the course of this investigation.

S. C. BHATTACHARYYA

Organic Chemistry Section,
Dept. of Pure & Applied Chemistry,
Indian Institute of Science, Bangalore.
21-9-1946.

ON THE CATHODO-LUMINESCENCE SPECTRA OF INDIAN FLUORITES CONTAINING RARE-EARTHS

SINCE Urbain's[1] researches on the cathodo-luminescence spectra of artificial mixtures and natural minerals containing rare-earths, investigations were carried out by Tanaka[2], Wick[3], Nichols and Howes[4], Yoshimura[5] and others. It was ascertained that rare-earths in quantities too small for detection by chemical analysis were effective as activators for luminescence.

In the present investigation, the presence of rare-earths in different specimens of Indian fluorite escaped detection by arc spectrographic analysis carried out at 10 amps. 220 volts with E_1 quartz spectrograph. An attempt was made to determine the rare-earths in fluorites which were effective as activators for cathodo-luminescence. The method of excitation for the specimens was by cathode rays, obtained in a tube specially designed according to Urbain. The vacuum in the tube was maintained by one stage mercury pump, run by a Cenco oil pump. The best condition for excitation of the specimens was at 4000 volts, the current in the tube being kept at 3·5 amps. The intensity of luminescence exhibited by the natural fluorites was generally weak. In order to increase the luminescence chemical treatment of the fluorite was necessary. The fluorites were converted into sulfates, then precipitated as carbonates and ignited to oxides at 1000°C in a muffle furnace. The rare-earths with CaO as the base exhibited so bright a luminescence that an exposure of 5-10 minutes was quite sufficient for taking a spectrogram.

For the study of the visible spectra a Direct Vision spectrograph with an arrangement for photographing a graduated scale was used. A Fuess Quartz spectrograph was used for the ultra-violet region and the sample holder in the cathode-ray tube was fitted with a quartz window. A Cu-arc spectrum was used as a reference wave length scale. The time of exposure for photographing the luminescence spectra in both spectrographs was 10 minutes, Barnet Panchromatic Plates being used. The identification of the line-like bands in the spectra of different specimens observed under a 'Comparator' of nearly 10-times magnification was carried out referring to Urbain's data for the different system of rare-earth oxide in calcium oxide (R_2O_3-CaO).

TABLE

RARE-EARTHS CONTAINED AS ACTIVATORS IN THE SPECIMENS OF INDIAN FLUORITES

No. of specimen	Locality	Colour of specimen	Colour of cathodo-luminescence	Rare-earths contained as activators.
*6251	Nandgaon and Khairagarh States, E.S.A.	Violet and green.	Deep violet, blue tinge.	Sm. Dy, Tb.
*6688	Malhan, Jubbulpore, C.P	White.	Orange-yellow.	No rare earths, Mn as activator.
† 1	Nandgaon, C P	Deep violet	White, light orange yellow tinge.	Sm, Dy, Pr.
† 2	,,	Green.	Violet, yellow tinge.	Sm, Dy, Tb, Er, Gd.
* 3	Bastar State, Bhopalpatnam.	Violet.	White, yellow tinge.	Sm, Dy, Tb, Er, Nd, Gd
* 4	Jaipur State, Rajputana	Green	Violet, orange tinge.	Sm, (Pr) Dy, Er, Tb, Nd, Gd.
* 5	Chitral	White, light green tinge.	White, blue violet tinge.	Sm, Dy, Tb, Er, Gd.

* Specimen from G. S. I. † Specimen from T. I. S. Co.

Our best thanks are due to Dr A. K. Dey of the Geological Survey of India, to Dr H. K. Mitra of the Tata Iron and Steel Co., for kindly supplying the specimens of fluorites and to the Director, C.S.I.R., for the grant-in-aid.

B. MUKHERJEE
P. B. SARKAR

University College of Science and Technology,
92, Upper Circular Road,
Calcutta, 7-10-1947.

[1] G. Urbain, *Ann. chim Phys.* (8), *18*, 222, 1909.
[2] T. Tanaka, *J. opt. Soc. Am.*, *8*, 501, 1924.
[3] F. G. Wick., *Phys. Rev.* (2), *24*, 272, 1924.
[4] E. L. Nichols and H. L. Howes, *J. opt. Soc. Am.*, *13*. 573, 1926.
[5] J. Yoshimura, *Sc. Pap. I. P. C. R.*, *23*, 224, 1933.

VACANCIES FOR SCIENTIFIC WORKERS

ASSISTANT PLANT PHYSIOLOGIST, Indian Agricultural Research Institute, New Delhi. Post Permanent. Grade Rs. 200—15—350—20—650, with initial upto Rs. 350 or as recommended by the Central Pay Commission. Age preferably below 35 years. Schedule caste candidates preferred.

Qualifications: M.Sc. degree in Botany or diploma I.A.R.I. in Botany, with Chemistry in the B.Sc. stage. Research experience for about 5 years.

Apply, Federal Public Service Commission, Simla before 15th November, 1947.

Indian Science News Association

PROCEEDINGS OF THE TWELFTH ANNUAL MEETING

The Twelfth Annual General Meeting of the Indian Science News Association was held on October 6, 1947, at 4 P.M. in the hall of the Applied Chemistry Department at the University College of Science, Calcutta.

In the absence of Mr D. N. Wadia, President of the Association, Prof. S. K. Mitra, Vice-President, was in the Chair.

The Annual Report of the last year (1945-46) were read and confirmed.

The Council of the Indian Science News Association have much pleasure in submitting this, the Twelfth Annual Report and the Statement of Accounts for the period July 1, 1946 to June 30, 1947.

Membership and Subscribers

During the year 1946-47, there was a decrease in one lifemember in the death of Mr M. N. Banerjee, making the total 111 and the number of ordinary members was 45, as against 57 of the previous year.

The total number of copies despatched in June, 1947 was 1537 as compared to 1497 in the same month of 1946. The number of subscribers in June 1947 including the members of the Association was 1310 as against 1335 of the preceding year. We had to strike off 36 subscribers from the list. Of these 21 discontinued and 15 were defaulters.

Exchange Journals

The total number of copies of the journal sent out every month in exchange and for review was 63. We received in exchange 25 Indian and 18 foreign journals. We also received journals of learned societies and publications of Government Scientific Departments. Several Calcutta newspapers, supply their daily issues in exchange as before as well as the well known Madras daily, *The Hindu*. As in past years we send the journal regularly to several Societies and Institutions on request.

Adair, Dutt Research Fund

The following scholars engaged in research work noted below are enjoying scholarships from the above fund:

(1) Mr P. Nandi—Micro-biology (now in England),

(2) Mr Pranbandhu Dutt—Chemistry.

We are grateful to Messrs. Adair, Dutt & Co. Ltd. for financial help in getting a series of articles on the riverine systems of India written by one who has specialised in the subject

(*For Statement of Accounts. See p. 4*)

Grants

We are grateful to the authorities of the University of Calcutta, the Bengal Chemical & Pharmaceutical Works, Ltd., and the Indian Association for the Cultivation of Science for renewing their annual grants. The amounts of these grants are as follows:

Calcutta University ...	Rs. 500/-
Bengal Chemical & Pharmaceutical Works Ltd.	,, 500/-
Indian Association for the Cultivation of Science ...	,, 100/-

Donations

During the year the Association was fortunate enough to receive the following donations from Messrs Adair, Dutt & Co., Ltd., Rockfeller Foundation and the Government of India, for which we express our sincerest thanks to them.

Messrs Adair, Dutt & Co., Ltd. ...	Rs. 1,500/-	
Rockefeller Foundation	,, 1,000/-	Through National Institute of Sciences.
Government of India ...	,, 750/-	

Our thanks are also due to the authorities of the Calcutta University for accommodating the office of "Science and Culture" in the University Science College building.

Conclusion

It may be profitable now just to have a look back over the past twelve years. While politicians have fought their battle of freedom from foreign domination, "Science and Culture" has not remained aloof a silent witness to the awakening. On the contrary, it may rightfully claim to have rendered pioneering service in trying to discover a common purpose in life for the whole of the Indian people, discussing ways and means to achieve that purpose, and suggesting measures.

It was in the pages of "Science and Culture" that the views of responsible thinkers in the country were broadcast for the first time for planning on a National Scale. Thus one of the achievements of "Science and Culture" has been to clarify the future objectives of the country—planned development of the resources in men and material so that our people may live at par with the civilized people in other progressive countries. "Science and Culture" has told the full story of experiments by Soviet Russia in this line, and also of Sweden, a country which is politically a monarchy.

To gain freedom and retain it are two vital but distinct phases of collective efforts. "Science and Culture" has spared no pains in preaching that the only way to attain the full objective is to achieve an all round Revolution in our methods of living and work. This alone can render the Political Revolution, which has culminated in Independence, conducive to our real well-being.

"Science and Culture" has advocated forced march to industrialization, nationalization of power and fuel, multipurpose development of rivers, establishment of scientific surveys, research laboratories, training of large personnel in scientific and technological work and development of educational facilities for all. It has preached unified development of India.

But this is not all. "Science and Culture" has endeavoured all along to uphold and propagate the cultural aspect of science, which is calculated to create an atmosphere for the peaceful progress of the society. For, one sided and mechanical application of science to multiply human comforts and human power in technically advanced countries of Europe has only led to an insane competition for power and pelf with what devastating results it is needless to recount here. A due emphasis on the cultural aspect of science, *i.e.*, on the fundamental ideas and methods of science, can alone serve as a wholesome brake and canalize the power derived from the application of science into fruitful and constructive efforts for the benefit of humanity. Science stands for truth, reason and unbiassed judgment, which enlighten the human mind and free it from the bondage of blind human prejudices, human sentiment and human passions. For these latter, particularly when fed by greed for power and gain, often run amuck spelling disaster and ruin for the society. What more striking and convincing illustration of this can be found than in the colossal barbarity and staggering savagery displayed by some of our own countrymen today. When human reason is thus dethroned by human passions and human sentiment, man is dragged down to the level of a beast. Propagation of fundamental ideas and methods of science among the masses is calculated to rationalize the human mind, and this constitutes, one of the principal objects of "Science and Culture", as mentioned before. "Science and Culture" can thus reasonably appeal to all our country men, Government and the public, for whatever help and encouragement they can extend towards its continuance, popularity and progress.

Handicapped as we are with poor financial resources, our Association has been solely occupied till now with only the monthly publication of its organ, "Science and Culture". Publication of brochures and maintaining a library with the journals received in exchange are objectives which are near to our heart. Publication of popular articles in Bengali for the dissemination of scientific knowledge among the masses forms also an important item in our plan. For the present "Science and Culture" will remain the Forum for advanced thinking and the mouthpiece of the best minds of the country.

With the advance of its thirteenth year of existence, "Science and Culture" pledges to strive in order to outbid its past. Co-operation of all in the vanguard of action and of thought can alone ensure its future achievements and progress.

(*For Statement of Accounts. See p. 4*)

The following persons were unanimously elected officers and members of the council for the year 1st July, 1947 to 30th June, 1948.

President.—Mr M. M. Sur.

Vice-Presidents.—Dr S. C. Law, Dr D. M. Bose, Prof. M. N. Saha, Dr W. D. West, Sir S. S. Bhatnagar, and Prof. S. K. Mitra.

Treasurer.—Prof. P. C. Mitter.

Secretaries.—Prof. P. Ray and Prof. B. C. Guha.

Members.—Prof. S. P. Agharkar, Dr B. Ahmad, Mr H. P. Bhaumik, Mr S. N. Sen, Dr K. Biswas, Mr N. R. Sarker, Col. Sir R. N. Chopra, Prof. K.

P. Chattopadhaya, Dr M. S. Krishnan, Dr J. C. Ghosh, Dr D. S. Kothari, Mr B. N. Maitra, Dr S. C. Mitra, Prof. H. K. Mookerjee, Dr J. N. Mukherjee, Hon'ble Dr John Mathai, Dr S. L. Hora, and Dr A. C. Ukil.

The Editorial Board of "Science and Culture" for the next year was constituted with Dr J. C. Ghosh, Prof. M. N. Saha, Dr A. C. Ukil and the two Secretaries as ex-officio members.

Inviting the Chief Guest to address the gathering, Prof. S. K. Mitra, who presided at the function, referred to the part played by the distinguished guest in the struggle for freedom for long 27 years. It was a happy termination that the valiant soldier now figures as one of the architects of the Province of West Bengal.

Hon'ble Sri Annada Prasad Chowdhury (Finance Minister to the Government of West Bengal), delivered his address in Bengali, as the Chief Guest on the occasion. He reminded the audience of eminent scientists that the Association should now propagate scientific knowledge in Bengali, with the same passion and fervour with which they are bringing out the English edition of "Science and Culture". He further stressed the role of scientists for the solution of the problem of poverty, famine and disease.

A full text of Sj. Chowdhury's address in Bengali and a verbative English translation of the same is printed elsewhere (see appendix).

Proposing a vote of thanks to the Chief Guest, Prof. M. N. Saha recalled the earlier abortive attempts for bringing out scientific journals in the language of the Province. Prof. Saha held that this was so because of the amateurish way in which such matters have been taken up in the past. He, however, offered the unreserved service of the Association in serving the national cause of reconstruction in liquidating poverty and famine and propagation of scientific knowledge in Bengali, provided necessary funds and encouragement were available from the Government.

(Statement of Accounts, next page)

INDIAN SCIENCE NEWS ASSOCIATION

(REGISTERED UNDER ACT XXI OF 1860)

Receipts and Payments Account for the year ended 30th June, 1947

RECEIPTS

	Rs.	As.	P.	Rs.	As.	P.
To *Opening Balance on 1-7-46* ..						
(a) At Bengal Central Bank Ltd. in Savings A/c.	1,286	3	10			
(b) At Bengal Central Bank Ltd. in Current A/c.	388	14	10			
(c) With Treasurer ...	105	5	9			
				1,780	8	5
,, Grant				1,100	0	0
,, Donation				3,250	0	0
,, Subscription				5,008	8	6
,, Life Membership Fee				326	0	0
,, Ordinary Membership Fee				335	0	0
,, Cash Sales of Journal				1,915	5	5
,, Advertisement				11,045	13	11
,, Reprint				827	4	0
,, Sale Proceeds of 3½% G. P. Notes (Nominal Rs. 5,000/-)				4,998	0	0
,, Interest				157	15	8
,, Adair, Dutt Research Fund ..				100	0	0
				Rs. 30,844	7	11

PAYMENTS

	Rs.	As.	P.	Rs.	As.	P.
By Establishment				6,204	0	0
,, Journal Printing				11,843	3	3
,, Paper				5,087	13	6
,, Postage & Receipt Stamp				1,068	4	0
,, Conveyance				36	5	3
,, Telephone				266	13	0
,, Miscellaneous				232	9	0
,, Audit Fee (re: 1945-46)				60	0	0
,, Stationery & Printing				338	2	0
,, Bank Charges				44	7	3
,, Adair, Dutt Research Fund				50	0	0
,, Advertisement Commission & Publicity				596	5	9
,, Furniture				600	0	0
,, Interest on Overdraft				68	0	1
,, Binding				45	0	0
,, *Closing Balance on 30-6-47* :-						
(a) At Bengal Central Bank Ltd. in Savings A/c. ...	502	2	5			
(b) At Bengal Central Bank Ltd. in Current A/c. ..	3,571	14	9			
(c) With Treasurer ..	299	7	8			
				4,303	8	10
				Rs. 30,844	7	11

AUDITOR'S REPORT TO THE MEMBERS, INDIAN SCIENCE NEWS ASSOCIATION

I have audited the above Receipts and Payments of Account of the INDIAN SCIENCE NEWS ASSOCIATION (Registered under Act XXI of 1860) for the year ended 30th June, 1947, with the books and accounts and vouchers and have obtained all the information and explanations I have required. I certify that the said account is correctly stated in accordance with the books of accounts of the Association.

6, Old Post Office Street,
Calcutta, the 23rd September, 1947.

Sd. P. RAY,
Sd. D. M. BOSE,
Hon. Secretaries.

Sd. A. K. GHOSH,
Government Diplomaed Accountant,
Registered Accountant,
Auditor.

Sd. P. C. MITTER,
Hon. Treasurer

ADAIR, DUTT RESEARCH FUND

Receipts and Payments Account for the year ended 30th June, 1947

RECEIPTS

	Rs.	As.	P.	Rs.	As.	P.
To *Opening Balance on 1-7-46* :-						
(a) At Bengal Central Bank Ltd in Savings A/c. ...	10,220	2	9			
(b) With Treasurer ..	264	4	0			
				10,484	6	9
,, Bank Interest				105	4	9
				Rs. 10,589	11	6

PAYMENTS

	Rs.	As.	P.	Rs.	As.	P.
By Stipend				5,090	5	0
,, Establishment				200	0	0
,, Accountancy Charges				15	0	0
,, Stationery				10	12	0
,, Postage				0	9	0
,, Conveyance				0	6	0
,, *Closing Balance on 30-6-47* :-						
(a) At Bengal Central Bank Ltd. in Saving A/c. ...	5,270	2	6			
(b) With Treasurer ..	2	9	0			
				5,272	11	6
				Rs. 10,589	11	6

AUDITOR'S REPORT TO THE MEMBERS, ADAIR, DUTT RESEARCH FUND

I have audited the above Receipts and Payments Account of ADAIR, DUTT RESEARCH FUND for the year ended 30th June, 1947, with the books and vouchers and have obtained all the information and explanations I have required. I certify that the said Account is correctly stated in accordance with the books of accounts of the Fund.

6, Old Post Office Street,
Calcutta, the 23rd September, 1947.

For Adair, Dutt Research Fund
Sd. P. RAY, *Secretary.*
Sd. G. BHATTACHARYA, *Treasurer.*

Sd. A. K. GHOSH,
Government Diplomaed Accountant,
Registered Accountant,
Auditor.

APPENDIX

মাননীয় সভাপতি মহাশয়, পূজনীয় অধ্যাপকবৃন্দ ও বন্ধুগণ—

আপনাদের নিমন্ত্রণে এই সভায় যোগদান করিবার সুযোগ পাইয়া নিজেকে সত্য সত্যই গৌরবান্বিত মনে করিতেছি। কিন্তু এই সভায় আমার শ্রদ্ধাভাজন অনেক অধ্যাপক উপস্থিত আছেন যাঁদের পদপ্রান্তে বসিয়া যৌবনে জ্ঞানার্জ্জনের সুযোগ লাভ করিয়াছি। তাহা ছাড়া এমন কয়েকজন এই সমিতির সহিত জড়িত যাঁদের অনুপ্রেরণায় যৌবনকাল হইতে সেবার পথে পরিচালিত হইয়াছি, তাঁহারাই আজ আমাকে অতিথিরূপে আহ্বান করিয়া সেই স্নেহের আসন হইতে যেন সরাইয়া দিতেছেন এই আশঙ্কায় নিজেকে কতকটা বিব্রতও মনে করিতেছি। আমি আশা করি এখন সেই বন্ধন পূর্ব্বের মতই বজায় থাকিবে এবং কর্ম্ম ও সেবার মধ্য দিয়া আরো ঘনিষ্ঠ হইয়া উঠিবে এবং তাহারই বলে এই প্রতিষ্ঠানের সকলের সঙ্গে একটা অবিচ্ছেদ্য সম্পর্ক গড়িয়া উঠিবে।

এই স্থান আমার ছাত্রাবস্থার অনেক স্মৃতি-বিজড়িত, রসায়ন শাস্ত্রের ছাত্র হইলেও নানা কারণে গত সাতাশ বৎসর যাবৎ ঐ বিষয়ের সহিত সম্পূর্ণ বিচ্ছিন্ন। পল্লী অঞ্চলেই সেবার কাজ করিয়াছি। পল্লীবাসীদের দুঃখ দারিদ্র্য দূর করিবার চিন্তাই যেন এতকাল আমাকে গ্রাস করিয়া রাখিয়াছে। এখন পশ্চিম বাংলায় মাত্র চৌদ্দটী সহর, প্রায় ২৪০০ গ্রাম। বাঁচিবার আশায় পল্লীবাসী সহরের দিকে ছুটিয়াছে। যথাসময়ে এই সমস্যার সম্মুখীন হইয়া এই তরঙ্গ রোধ না করিলে শুধু গ্রামগুলি ধ্বংসপ্রাপ্ত হইবে তাহাই নহে সুচিন্তিত পরিকল্পনা এবং সুশৃঙ্খল কর্ম্মব্যবস্থার অভাবে সহরের অবস্থা আরোও বেশী জটিল হইয়া পড়িবে। এই সঙ্কট হইতে উদ্ধার পাইবার জন্য সমগ্র জাতি বুকভরা আশা লইয়া সতৃষ্ণ নয়নে চাহিয়া আছে আপনাদের দিকে।

আপনারাই সেই সঞ্জীবনী মন্ত্র উচ্চারণ করিতে পারেন, আপনারাই পারেন জমির ফলন বাড়াইতে। আপনারা জানেন দেশের স্বাস্থ্য ও সম্পদ ফিরাইয়া আনিতে। দেশবাসী এবং তাদের প্রতিনিধি স্থানীয় গভর্ণমেন্ট তাই আপনাদের নিকট পথের সন্ধান চায়। আসুন আপনারা আমাদিগকে পরিচালিত করুন।

অনেকদিন হইতে আপনাদের সমিতির মুখপত্র হিসাবে Science and Culture প্রকাশিত হইতেছে। বাহিরে সম্ভব না হইলেও জেলে উহা পড়িয়াছি। আপনারা নিশ্চয়ই জানেন যে সরকারী অফিসে বাংলাভাষা প্রচলন করা স্থির হইয়াছে। অফিসের ফাইল, বাংলায় লেখা আরম্ভ হইয়াছে; বাংলাভাষায় শিক্ষাও দেওয়া হইতেছে। কিন্তু বৈজ্ঞানিক পরিভাষার একান্ত অভাব। এই সমস্যার সমাধান করাও আপনাদের হাতে। যত তাড়াতাড়ি এই সমস্ত বিষয় নিজেদের ভাষায় চালাইতে পারি তত তাড়াতাড়ি আমরা পরাধীনতার পরোক্ষ শৃঙ্খল মুক্ত হইতে পারিব। এই কাজেও আপনাদের সাহায্য অত্যাবশ্যক। অতএব নিবেদন এই যে Science and Cultureএর প্রতি সংখ্যায় যে কোন একটি প্রবন্ধ বাংলা ভাষায় প্রকাশিত হইলে নূতন নূতন বাংলা বৈজ্ঞানিক শব্দ লিখিতে পারা যাইবে এবং যাঁরা ইংরাজী জানেন না তাঁরাও ঐ অংশ পড়িতে পারিবেন। কিছুদূর অগ্রসর হইয়া এই ধরণের বাংলা মাসিক পত্রিকা প্রকাশ করার চেষ্টাও করা যাইতে পারে।

তারপর আর একটি কথা বলিয়াই আমার বক্তব্য শেষ করিব। উহা আমাদের শিল্পনীতি। অতি অল্প পরিমাণ আয় করিতে থাকিলেও আমরা কাহাকেও নিজ নিজ কাজ হইতে বঞ্চিত করিতে চাই না। বেকার সমস্যাও আমাদের বিরাট জাতীয় সমস্যা। আসুন আমরা সকলে মিলিয়া যাদের কোন কাজ নাই তাদের কাজের সৃষ্টি আগে করি। Industrialisation যেন কেবল Industrialisationএর জন্যই করা না হয়। ঠিক সেই রকম আবার Engine Boiler বলিয়া উহা দেখিয়াই যেন আমরা শঙ্কিত হইয়া না উঠি।

আমরা চাই যে আমাদের নিত্য প্রয়োজনীয় দ্রব্যাদি যথা খাদ্য ও বস্ত্র প্রভৃতি যথাসম্ভব বিকেন্দ্রীভূত অবস্থায় ব্যবহার-কারীদের নিজ তত্ত্বাবধানে উৎপন্ন হয়। অতএব এই কারণে ইহাও যেন না ঘটে যে লাঙ্গল দিয়া চাষ করিলে sub-soil water শুকাইয়া যায় না; অতএব সেই পুরাকালের লাঙ্গলই চিরকাল বজায় থাকিবে। আবার পুরাকালের লাঙ্গল ত্রুটি-বিহীন নয় বলিয়া একেবারে ট্রাক্টরই যে আমাদের দেশের অবস্থায় সর্ব্বাঙ্গসুন্দর এই ধারণা করিলেও চলিবে না। বৈজ্ঞানিকগণ চেষ্টা করিলে এবং পল্লীবাসীর অবস্থার সহিত যোগ থাকিলে এমন যন্ত্র উদ্ভাবন করা যাইতে পারে যাহাতে লাঙ্গলের অসুবিধা দূর করিয়া ট্রাক্টরএর সমাবেশ করা যাইতে পারে। এবং তদ্দ্বারা সর্ব্বতোভাবে কৃষির উন্নতি করা যাইতে পারে। নিত্য প্রয়োজনীয় সব জিনিষের সম্বন্ধে এই একই কথা।

ঘানি, তাঁত, ঢেঁকি প্রভৃতি এই সব বিষয়ে এক কথা বলা যাইতে পারে। আসুন কৃষককে তার অবসর সময়ে কারখানায় টানিয়া না আনিয়া তার উৎপন্ন কাঁচা মালকে তার কুটিরে যতদূর সম্ভব ব্যবহারোপযোগী অবস্থায় (consumbable stageএ) পরিণত করিবার জন্য আপনাদের মেধা ও উদ্ভাবনী শক্তি প্রয়োগ করুন।

তবে উপরোক্ত মন্তব্য হইতে যেন মনে না হয় যে আমি সর্ব্বপ্রকার যন্ত্রশক্তির বিরোধী। লৌহ ও ইস্পাত, ক্লোরিন, ব্লিচিং পাউডার, Dyestuffs and chemicals, Soda, এ্যালু-মুনিয়াম প্রভৃতি শিল্প হিসাবে গ্রহণ না করিলে আজকাল চলিবে না। তবে আমরা মানুষকে যন্ত্রের মালিক করিতে চাই, মানুষ যেন বিরাট যন্ত্র শিল্পের দাসে পরিণত না হয়। এর সামঞ্জস্য বিধান আপনারা করিতে পারেন। আজিকার এই আলোচনা যেন ঐ সামঞ্জস্য বিধানের দ্বারা সর্ব্ববিধ শিল্পোন্নতির পথে আমাদের উদ্বুদ্ধ করে এবং দীন-দুঃখীজনগণের সেবায় আমাদের সকলের জীবন মহিমান্বিত হইয়া উঠে।

Mr President, Professors and Friends,

I sincerely feel honoured to be able to attend this meeting at your invitation. But here I see before me many revered teachers present at whose feet I had the privilege of acquiring knowledge in my youth. And there are also present here some associated with this organization whose inspiration has guided me in chosing a career of service at the dawn of my life and I am really embarrassed at the thought that by calling me to this Chair they are perhaps removing me from the place of affection that I had so long occupied in their hearts. But I do hope that the ties that bound us in the past will continue today, and will as a matter of fact draw us together closer than ever through service and labour for a common objective as a result of which a permanent relation will be built up.

Many memories of my youth are tied up with this place. Though I used to be a student of Chemistry here, yet for various reasons for the last 27 years, I have lost touch with that subject. The thoughts of removing the poverty and misery of villagers had possessed me all these long years. Even now in West Bengal there are only fourteen towns as compared with 2400 villages. The desire for survival is forcing the villagers to migrate to the towns. Unless we can intervene timely and face this problem and prevent this rush to the towns, not only will the villages be destroyed, but the absence of a well-conceived and co-ordinated plan will make the situation in the towns more than ever complex. It is to you that the nation is eagerly looking in order to be saved in this crisis.

It is you who can utter the magic call to life ; it is you who can increase the productive capacity of the land. In you lies the secret of bringing back the health and prosperity of the country. Therefore the country and the government which is its representative want from you direction that will point the way out. Will you not extend to us your guidance ?

You have been publishing for a long time your journal—'*Science and Culture*' as the mouthpiece of your organization. Though it had not been possible outside, I had the opportunity of reading it while I was in jail. You are surely aware that it has been decided to introduce the vernacular for transaction of work in government offices. Official files are changing over to the Bengali, in which necessary instructions are being arranged. But a glossary of scientific words in Bengali is more than ever necessary. It lies with you to tackle with this problem. The earlier we can carry on our work in our language, the sooner will we be able to free ourselves from the indirect bondage of subjection. In this task also your help is more than ever necessary. Therefore my suggestion is that in every issue of the *Science and Culture*, if you publish at least one article in Bengali, it will be a step towards the discovery of new scientific words in Bengali, and will afford an opportunity to those who do not know English to be interested in your journal. After the initial steps have been taken it may even be possible to undertake a journal in Bengali of this type and standard.

Just one thing more before I bring these observations to a close. It is about our industrial policy. We do not want to deprive even those who earn a bare pittance from pursuing their vocations. The problem of unemployment is a big national problem. Let us first create work for those who have no work. Let us not take to industrialization for the sake of industrialization. At the same time there is nothing to be frightened in an engine-boiler as such. What we want is that our everyday needs like food and clothing may be produced under the supervision of the consumers under a system of decentralization. We should also see that for the fear lest subsoil water is exhausted, we do not cling to the ancient plough. Nor must we take it for granted that the tractor is the only alternative. If scientists make the effort and keep touch with the agriculturists, it may not be impossible for them to devise implements which will dispense with the shortcomings of the plough and utilize the advantages of the tractor—and thereby bring about an all-round improvement in our agriculture. And this holds good of all our daily needs. Let us not drag away the cultivator from the fields to the factories, but instead let us try to devise means by which the raw materials produced by him may be converted into consumers' goods in his cottage.

Please do not conclude from what I have just said that I am against machinery. We have got to produce to-day on an industrial scale and for industrial purposes iron and steel, chlorine and bleaching powder, dye-stuffs and chemicals. But what we want is that man must be master of machines. I do not want to make him the slave of machines.. It is for you to find out how this might be done. I wish that as a result of this day's discussion you may contribute to the realization of this and set us on the way to industrial development, so that our lives might be truly blessed in the service of poor and suffering humanity.

SCIENCE AND CULTURE

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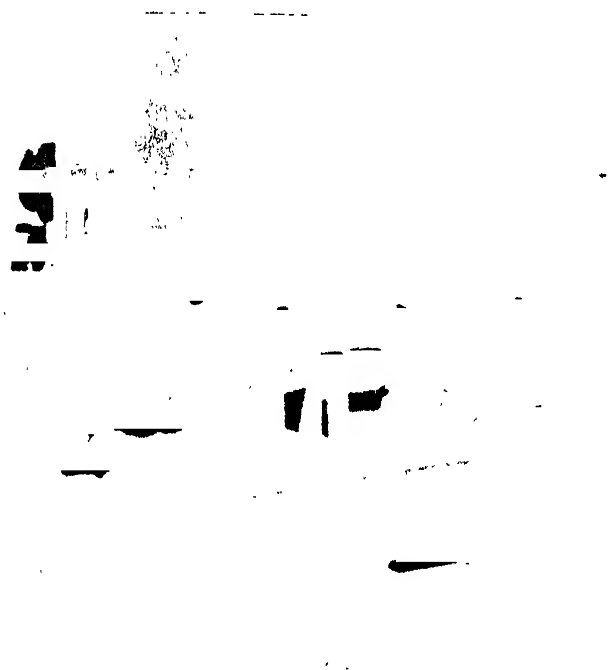

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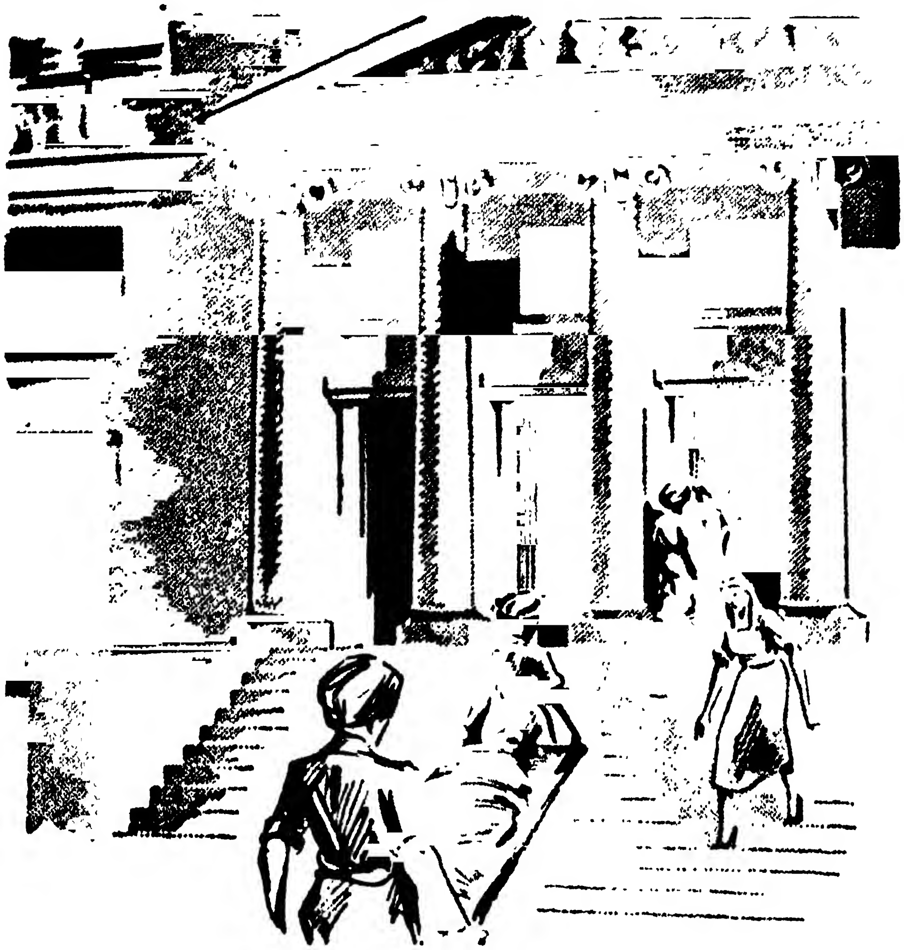

SCIENCE AND CULTURE

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SCIENCE AND CULTURE

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FOOD

THE problem of food has assumed serious proportions in large parts of the world. The total food production in the world is considerably short of the requirement if all the people are to be maintained on an adequate nutrition level. The exportable surplus from the major food producing countries like North America, Argentina, Australia, etc., cannot meet the requirements of the world. The position is aggravated by the fact that while Asia, Africa, Central America, and parts of South America are living on a semi-starvation level, grains have been fed to livestock in North America (though of late there is a welcome tendency to divert more of the surplus grains to the food-deficient countries). The central paradox, of course, is that while many countries of the world are demanding food which should have rationally led to greatly increased food production, the fear of falling prices is acting as a brake on production in some food-producing countries. It is true that the U.S.A. has considerably increased her production for world markets and has got a record harvest this year. But the haunting fear of depression is not allowing expansion of production on the scale required to meet the needs of the world. On the other hand food-deficient countries like India are not being able to make much headway because of the world shortage of fertilizers, agricultural implements, etc. Having a low purchasing power countries like India, China, Indonesia, are getting a far less proportion of the world's food supplies than they require on the basis of their population. The following table shows that of the world's food supplies Asia, Africa and Latin America get considerably less in proportion to their populations than Europe, North America and Oceania.

TABLE

PER CENT DISTRIBUTION OF WORLD'S FOOD SUPPLIES.

	Europe excluding U.S.S.R.	Europe including U.S.S.R.	North America	Latin America	Africa	Asia	Oceania
Cereals, excluding rice ..	31·9	43	25·3	8·8	3·2	17·4	2·3
Crude, foodstuffs	31·4	47·6	34·6	6·6	2·7	6·7	1·8
Cereals and other foodstuffs, including rice	28·4	41·2	24·4	5·8	2·5	24·0	1·6
Meat	36	45·7	29·7	11·9	3·4	5·6	3·7
Coffee, tea, cocoa	0		--	42·4	12·3	45·7	0·2
Population, in millions .	385	549	137	124	144	1,114	11
Percent. of world population .	18·2	25·9	6·5	5·7	6·7	52·5	5·5
Area, in millions of acres .	1,340	6,500	5,000	5,180	7,500	6,600	201

It will be seen that Europe (minus U.S.S.R.) having a population of one-third of that of Asia gets more cereals and 6 times the meat that Asia gets.

The World Food Council set up by the F.A.O. is expected to help in providing a sort of a World Food Bank so that so-called surpluses might not depress the market but might be held in reserve and diverted to those countries which need the food with the assistance of the International Monetary Fund which might provide credit to the purchasing countries where the purchasing power

is low. This is, however, a problem transcending the question of food only and impinging on the economic and even political interests of certain countries and classes. How far, therefore, international collaboration will be successful without a radical alteration in the socio-economic structure of the world remains to be seen.

We are more particularly concerned with the problem in India. The Bengal famine of 1943 carried away nearly 3 millions of people, left many millions as human wrecks and irreparably undermined the health of a large part of the coming generation. In 1946 again there was the fear of a famine in South India and Bengal which could be averted only by intensive procurement, imports and by reducing cereal rations to as low as 8 oz. per day per head for people who can hardly afford to eat anything but cereals. There was an apprehension of famine again this year, and in many parts of Bengal, particularly East Bengal, prices of rice soared to Rs. 50 per maund.

India has to tackle her problems chiefly by her own efforts. The dependance on cereal grains from other countries is costing her foreign exchange of the value of about 125 crores of rupees annually. Perhaps it would have served India much better if at least half of this money were utilized for developing land, applying fertilizers, promoting irrigation, etc. Food production is bound up in India not only with the application of science and technology to the problem but with the whole system of land-tenure which requires urgent and drastic overhaul. Without collective agriculture which will enable the introduction of scientific methods, agriculture can hardly make striking advances in India. The technical methods of American and Soviet farming if applied to India with proper adaptations would considerably increase production. Meanwhile, the population is increasing in India at a rate of about 5 millions a year. The struggle for food, therefore, must be continuous and must utilize all the resources of science and technology.

Some aspects of this problem are dealt with in an article by Prof. V. Subrahmanyan entitled "A practical approach to the food problem in India" published elsewhere in this issue. He considers that the increasing population of India will continue to outpace food production or, at any rate, the gulf between the two is hardly likely to be bridged unless organised administrative and scientific measures are taken on a planned basis. We should not live precariously on imports and particularly in a world where there are wars and rumours of wars and we may suddenly be cut off from imports. We have suffered from famine and also hovered on its brink too often to allow this problem to drift.

There are many aspects of the question, all of which require co-related attention. A new attitude is called for. Along with short and long term policies for the production of more food by the usual methods of extending irrigation, using better seeds, preventing soil erosion, reclaiming waste land, mechanising agricultural operations, etc., it is necessary to take recourse to what may be called unconventional methods, which would require research as well as some changes in our food habits.

Potatoes and tubers generally are heavy-yielders and, although they provide less concentrated foods than cereal grains a net gain in the supply of food for the nation will be obtained by producing larger quantities of tubers than now and changing food habits in that direction.

In Bombay during 1946, ground-nut flour obtained after expressing the oil was used with atta. If used in proper proportion, this does not adversely affect palatibility while it actually increases the nutritive value. In fact, in America, the incorporation of ground-nut flour in bread is being advocated. Other seed cakes like those of sesamum and of mustard can also be prepared as human food during an emergency and it is desirable that results of researches on these problems are available for ready application in case of necessity. The normal use for seed-cakes must, however, remain for cattle and for manure.

In several parts of the country, raw rice is preferred to parboiled rice because of taste. But it is known that parboiled rice is nutritionally superior to raw rice and also that in the production of parboiled rice there is a greater out-turn of whole rice, because of less breakage, than is the case with raw rice. It has been estimated that about 400,000 tons of *more* rice for human feeding might be available per year, if, by legislation or otherwise, all the rice produced in India were parboiled barring about 10% of the rice now used raw, which might be required for religious purposes or by 'conscientious objectors'. Parboiled rice is, however, often considered 'smelly' by raw rice-eaters. It is therefore necessary to improve and standardise the parboiling process now in vogue, which would require some investigation. Variations of the parboiling process like 'rice-conversion' and Prof. Sanjiva Rao's 'calcuring' process should also be considered in this connection.

The question of the use of green leafy materials for human food has come into prominence during recent years. Apart from the use of green vegetables as sources of vitamins, they are being increasingly considered as possible sources of good protein. Green leaf protein is now known to be almost equivalent to meat protein in biological value. Selection of right types of green leafy materials and their

proper processing would indicate a new direction in the solution of the food problem.

Technological advances in Germany have produced food from wood and fat from coal during the last war. That which appears to be a strange method of getting food today may become the usual method tomorrow.

The above are just some examples to illustrate the need of a new popular as well as scientific orientation on the food problem. Many of these problems could be tackled most effectively in a Food Technology Institute, which we hope the Government of India will shortly establish. But we require not only extensive and intensive researches on the science and technology of food but also their integration with problems of policy and administration. Scientists are still 'on tap' and not on top and until science and administration are integrated at the highest level there is no future for this country. It is time that there were a permanent body in the Central Government which can co-ordinate both research and policy and which has powers to implement that policy. Unless this is done, the hand-to-mouth efforts of our administrators to keep the wolf from the door will never lead to a satisfactory solution of the food-problem for our increasing population. We are convinced, however, that if this problem is tackled on a scientific and comprehensive basis, our population instead of being a liability can become an asset.

A PRACTICAL APPROACH TO THE FOOD PROBLEM IN INDIA

V. SUBRAHMANYAN,

INDIAN INSTITUTE OF SCIENCE, BANGALORE

THE tragic experience of 1943 and the continued difficulties of the past three years have glaringly revealed the true position in regard to food in India. The conditions were very trying during 1946, following the extensive failure of monsoons during 1945. A large part of the country—especially South India—had to carry on precariously during the summer and autumn of 1946. But for the co-operation and generous support of other nations, a fairly efficient system of procurement and distribution within the country and a severe form of rationing, the country would have been the scene of one more famine perhaps more tragic than that of 1943. The repeated shocks have led to a general awakening and an increasing realization that India's food problems have come to stay.

WE MAY SOON HAVE TO FACE ANOTHER FOOD CRISIS

The causes which led to the present position are fairly wellknown. During the past thirty years our agricultural production has remained more or less stationary, while our population has steadily increased. From the favourable position of the exporters of agricultural produce, we have steadily deteriorated into that of importers. We are now at a stage when a strict system of rationing, combined with the import of a few million tons of food per annum, will just meet our requirement. The favourable monsoons of 1946 have somewhat eased the position for 1947, but the outlook for future years is still uncertain. The country will have to prepare for worse years. When the season is less favourable, the available food is certain to be less and the demand from the growing population considerably more than it is at the present time. *The present rationing system will work only as long as there is a minimum amount of food to go round and a large section of the population (especially in urban areas) has the means to purchase the rationed quantity.* Judging from the trends, the present position is not likely to be maintained for long. We have to take heed of the signs and prepare for the future.

The factors that will disturb the present system are, chiefly, the following:—(*i*) the inevitable further increase in population, the annual increase being between 5 and 6 millions; (*ii*) the fast advancing post-war depression, with diminishing average income and increased unemployment; (*iii*) the greater home demands of the producing countries with increasing requirement for grains and tubers as raw materials for different industries; (*iv*) reduced exports owing to advancing foreign competition and, consequently, diminishing purchasing power of the country as a whole; and (*v*) general unrest among the people owing to a clash of ideals—religious, communal and so forth. Against these, may be considered (*a*) greater food production by improved irrigational facilities and agricultural methods within the country; (*b*) improved conditions in Europe, Japan and other war-ravaged countries, thus releasing more

food for being diverted to India; (c) improved industrial development within the country when all the planned industries come into being and thus make more money available for the purchase of food when and where needed.

On comparing the two sets of factors, it would not be difficult to predict that our demand for food will steadily get ahead of our capacity for production; that the purchasing power of the people and of the country as a whole will tend to diminish owing to the inevitable post-depression; that if fresh difficulties are to be avoided, it will be necessary to utilize our available resources in the most efficient manner possible. It is here that the fullest co-operation between the scientist and the administrator is needed.

The Scientist should have an Effective Voice in Food Planning

To the administrator, India's food problem is essentially one of procurement and distribution of food grains. Even this is admittedly a very difficult task and the administrative machinery of the Central Government, the Provinces and the States deserve a lot of credit for organizing and working the present system of procurement and rationing of grains. The efficiency of the system would depend on continued food supplies in sufficient quantity being available; on the food materials keeping in good condition and being clean and healthy. Added to that, it is a responsibility of the State to see that the people get the necessary quantities of the different supplementary and protective foods. All these can be done only if the scientist has an effective voice in food planning.

Our Requirements and Capacity for Production

There is some difference of opinion regarding the actual population of India at the present time. In any planning it is desirable to err on the safe side; so, we may assume that in 1947 it is about 450 millions. By 1957 we would be reaching 500 millions, if not more. We should, therefore, plan ahead for 500 millions and the plan should also take into account the possibility of a further increase.

We may divide the population for the next five years into four main groups—180-200 millions of people whose chief diet is rice; 125-140 millions of people whose chief diet is wheat; 100-110 millions who live mainly on millets including jowar, ragi, bazra and maize; and about 10 millions who consume chiefly tapioca and other tubers. Taking only rice as an instance, we would require about 33 million tons of the hulled grain if we are to provide 1 lb. of rice per head and about 25 million tons if we provide 12 ounces per head. The recent experience has shown that the country's production, together with the imports, will be just about enough to maintain between 10 and 12 ounces. An increase of at least 25% in supply will be needed if we are to maintain a ration of 1 lb. per head.

A great deal of valuable work has already been done on the effect of various factors on the yield of rice. By choice of right variety, efficient cultivation operations and proper manuring it should be possible to increase the yield by as much as 50%. This high figure cannot, however, be attained in large-scale practice. Moreover, there is not enough scope for applying known findings. Thus, even if we apply 1 cwt. of ammonium sulphate per acre we can expect an average increase in yield of about 10%. We have 80 million acres under rice, so, to achieve this end, we will have to find about 4 million tons of the fertilizer! We do not have even a small fraction of this for all our crops put together. It would thus be seen how difficult it would be to effect even a slight improvement in the present yield of crops.

We can effect a definite improvement in the yield of rice from paddy if the grain is parboiled as is done in some parts of India. The average improvement will be between 5 and 10% and that will mean that between one and two million tons extra food will be available. Parboiled rice is more slowly digested than raw rice, so, the total consumption in that form would also be about 5% less than that of raw rice. In some parts of the country, there is prejudice against using parboiled rice, but that can be overcome. In many factories the parboiling is not done with the necessary care, but that can be rectified. Parboiled rice is more nutritious than raw rice and in due course, the consumers will appreciate its good qualities. In the ultimate interests of the country and the people, there should be compulsory legislation enforcing the use of parboiled rice excepting for religious and other special functions for which raw rice is required. Converted rice is also a form of parboiled rice and, wherever it is to the advantage of the country and the people, plants for the production of converted rice may also be set up.

At the present time a good deal of land is in a state of neglect or indifferent attention. This is partly due to ignorance, but more largely to the fact that the tenants have no interest in it. To the absentee land-lord the land is only a form of investment yielding a low rate of interest. This system should be eventually abolished and it should be legislated that a person who owns any land should also be there to cultivate it. In the meantime, there should be a State organization for inspecting all the lands and reporting on their condition. If any land

is not in the condition in which it should be, there should be a competent agricultural Inspector or other officer to report on it and suggest improvements. If these improvements are not carried out, there should be some form of penalty. The working of the system may have some defects, but it would turn out to be fundamentally sound.

Being situated in the tropics, the depletion of the land is continually going on. The soil has rarely any cover that will keep it loose and, at the same time, protected. Every soil should have some protection that will reduce the risk of rains washing away the fertilizing ingredients. In this direction also, a regular service for advice and assistance is needed. There should also be a provision for the State to assist in fertilizing lands, but there is not enough fertilizer to go round.

Need for Storage and Reclamation of partially Spoilt Grains

Millets and other dry crops depend mostly on the monsoons and other favourable weather conditions. In good years, they give sufficient yields for meeting the needs of man and the animals. In bad seasons, which are not infrequent, they fail badly. The most efficacious procedure will be to build substantial reserves, each area building up its own pool. The State should build up granaries, the farmers being encouraged to store in them. There are two efficacious methods of storage—one by reduction of moisture and the other by the use of chemicals. Both the methods are useful and installations should be set up wherever possible. If co-operative storage does not work, the State can buy the grains when they are plentiful and store them. Millets perish rapidly through insect attack and everything possible should be done to preserve them for meeting the needs of lean years.

Wheat responds the same way as millets, but being also an irrigated crop, the yields are less liable to variation than in the case of millets. Storage of wheat is well known and simple methods suited to Indian conditions should be adopted extensively. Apart from the Government, the local bodies should also take active interest in encouraging modern methods of storage.

At the present time, there is extensive spoilage of grains through various causes. All spoilt grains are not unusable; in fact, quite a lot of it can be reclaimed and rendered useful. We should have a nationwide service in this direction. Treatment plants should be set up at the major centres. There should also be advice and assistance for treatment even on a small scale in the homes.

Milk, Meat, Eggs and Fish

Milk and other dairy products are highly important. Apart from being first class articles of food, they are also protective foods. As discussed in a previous contribution, we do not at present get even one-fourth of our requirements of these products. Every possible effort is being made to step up production, but our main limiting factors will be fodder and concentrates. More and more land will have to go under human food production and it will be very difficult to increase milk supply *per capita* above the present level, especially when considering the rapid increase in population.

Similar difficulties will also be experienced in regard to meat and eggs. At present, these two concentrated forms of high class food are not rationed. The richer classes can afford to get their requirement, while the poor classes have to go largely without them. The position is not likely to improve and more and more people will have to change over to purely vegetable food materials.

The prospects in regard to fish are fairly promising. India has an extensive coast line and the prospects in regard to sea fishing are fairly good. If the plans which are now being prepared are carried to their logical conclusion, there should be increased supply of fish in the years to come. It is hoped that the related food industries will also be soon developed.

Our Chief Problem is one of Foodgrains and Vegetable Food Materials

India's main problem is, however, essentially one of foodgrains. The majority of people are, and will continue to be, vegetarians either because of tradition and religious scruples or on account of economic conditions which would take meat and other expensive animal products beyond the reach of a large section of the people. We will, therefore, concentrate our attention on foodgrains and other vegetable food materials.

The irrigation projects, now on hand, as also those which are being planned will bring a few more millions of acres of land under cultivation. They will help to provide about 10% more food. A similar argument would apply to the inclusion of the cultivable wastes; and reclamation of soil which has suffered through erosion. These are essential steps and they will also help. It will not, however, be a wise measure to encroach on the forest areas and to convert them into agricultural lands. Apart from their other advantages, the forests provide our fuel and timber and we cannot afford to destroy them. There is already acute shortage of firewood and charcoal over a considerable part of the country.

We have at present no effective procedure for maintaining even the 12 ounce ration without resorting to imports. There were fairly good crops during the latter half of 1946, but the subsequent years may see poorer crops. In that case, we may have to resort to larger imports. Added to this, there are at least five million more people to be fed every year. Even imports—we get only a part of what we ask for—cannot maintain us from year to year. Unless we have alternative sources of food which we can depend on, we will soon have to face another crisis.

Additional Sources of Foods—Leafy Foods

By tradition and habit, a large majority of people in the country have from time immemorial been consumers of grains which are quite concentrated forms of food. We do not always get sufficient quantities of grains, and, more recently, trials have been carried out over different parts of the country incorporating powdered seed-cakes with cereal flour. We are even more accustomed to leafy foods which in season are quite plentiful. Leaf crops are more dense and yield much more heavily than grain crops. We should extend this idea and search for more of leafy vegetation which are soft and succulent and which could be grown on agricultural lands either permanently or as annuals. The tender leafy materials can be dried or otherwise processed and powdered. In that form, they will make good additions and supplements to the available supply of cereals. This is an extremely potent method of adding to our food resources.

A cereal crop like rice can yield 1,000-1,500 lbs. per acre. That would produce between 500 and 750 lbs. of the finished edible material. A leaf crop can yield 20-50 tons or more per acre. Even allowing for the comparatively high moisture content, the net dry weight will be many times more than what we can obtain from a grain crop.

If dried and processed food in this form is available in sufficient quantity, we can add it in any desired proportion to our available supply of cereal food. We can mix it with flour or issue it separately as a supplementary food. If we can produce, say, 5-6 million tons of dry food in this manner, we can face any immediate shortage of grains.

A great deal of valuable work has been done on the composition of leafy foods at different stages. They are most useful in the tender form when they also contain the least amount of fibrous matter. They are rich in vitamins, minerals and other accessories. Elvehjem and his associates in America and Guha and co-workers in India have demonstrated their high supplementary value. Some of them are also rich in proteins (5-10%). They are far better foods, on the whole, than tubers which are poor excepting in regard to starch. They are also preferable to seed-cakes which, though concentrated, are very difficult to digest.

All over India, we use leaf crops as vegetables. We are familiar with them and we like them. No research is needed to determine their suitability as human food. What is urgently needed, however, is an intensive programme to determine the best and the cheapest methods of processing them, as also conditions for drying and storage. The keeping qualities of the final products will have to be carefully followed. On the agricultural side, the methods of large-scale production and harvesting will have to be worked out. It may be possible to produce the leaf crops between two grain crops.

There are, of course, hundreds of edible leaf materials which are not at present used as human food. These would require systematic study both in the laboratory and on the field. There should be a big nation-wide programme with several research laboratories and agricultural stations working together at the same time. The results are bound to be useful from both the scientific and the practical points of view.

Tubers as Additional Foods

The desirability of producing more tuber crops has been stressed both by the Famine Enquiry Commission, and more recently, by Prof. Afzal Hussain. The potato, sweet potato and tapioca are already established in the country and are quite heavy yielders. They can be used either in the fresh condition or in the dehydrated forms. The latter are still quite expensive and improved methods should be found for drying them cheaply and without loss of useful food constituents. Cheap and efficient methods of storing the dehydrated products should also be worked out. The tubers are relatively poorer articles of food than the grains and they require to be amply supplemented with proteins, fats, minerals and vitamins. In this respect the leafy foods would be preferable. Perhaps tubers and leafy vegetables can both be used as supplements to each other and added to our available supply of grains, which will continue to be our main source of food.

The importance of developing these lines to the stage of practical application cannot be overestimated. We may have to face another food crisis at any time and we should not be unprepared. We cannot go on depending on food imports, which, apart from their being a source of continued drain to the country, are not likely to come up to our increasing requirements. We have to help ourselves.

Need for more Work on Alternative and Supplementary Foods

A great deal of work still remains to be done in the line of alternative and supplementary foods. There should be continuous search not only from among potential sources within the country but also in other parts of the world. Several new forms of food can thus be discovered. Some of them may be from heavy yielding plants while others may be derived from plants capable for flourishing under dry and arid conditions or under conditions of heavy rainfall and in forests. The subject requires fresh approach with a new outlook and vision.

Food Research requires more Encouragement and Support

The subject of food research requires far more encouragement and support than it has yet received. As it is, there is very little of scientific recognition and appreciation of efforts in this field. *Although there is a good deal of talk about encouraging applied research, the people—with a few exceptions—who are really on top and who get most of the State patronage and support are pure scientists. They are the Government advisers and they shape the destiny of science in the country.* The people who make positive contributions in vital lines like food are practically forgotten. If this state of affairs is not remedied, it will not be possible to attract the best talent for applied research.

Studies on the processing of concentrated foods like soya-bean and different oil-seeds and cakes should be further intensified. Although the rest of the world has gone ahead with dozens of uses for soya-bean, we are still having a stiff uphill task in demonstrating the food value and popularisation of soya-milk. The task of the scientist becomes very difficult when he has to contend against old prejudices; when he has to do all the laboratory work, animal experiments, human feeding, large-scale production and at the same time popularise the product.

On the agricultural side of food production, a great deal of organisation is still needed. In addition to better soil management, we require a big organisation for conserving our manurial resources and for utilising every possible source of fertilising ingredient. One of our biggest drains is through sewage and we should have a nationwide policy for conserving all the fertilising ingredients present in sewage.

Although we have quite a large number of scientific workers, we are yet short of the highest type of talent that could plan with vision and organise large-scale effort. The number of experienced workers in each field is very small and this is borne out by the fact that practically the same persons figure in various planning committees. Even these people can give only part-time attention to each subject, so much so that there is very little concentrated effort in any direction.

Need for a Central Organisation for the Study of Food Problems

For the best part of a year, the author has pleaded that, as food is the foremost problem of the country, the State should have a central organisation—including some of the most experienced scientists in the country—which will be concerned exclusively with the day-to-day food problems; in planning and organising various lines of scientific work bearing on food; also conducting extensive field studies and arranging for demonstrations at different centres. The organisation will work in close association with economists, agriculturists and health authorities. The staff will have to work on wholetime basis as, otherwise, it will not be possible to devote concentrated attention to the important problems on hand. There should be ample provision of funds with discretion for use in the best interests of the work.

It may not be difficult to organise such a team if the State takes sufficiently keen interest in the subject. Scientists would be willing to help in a national effort: at the same time the State would give them every possible support.

Even at the present time, there are not many who are not sufficiently alive to the gravity of the situation. Our position in regard to food is quite precarious and we may, at any time, be faced with another crisis. We should not be unprepared: nor should we go on begging of other countries for food.

The main Cause of our Trouble is the Uncontrolled Increase in Population

While every possible effort should be made to meet the increasing food demands of the country, the State should also tackle the root cause of the trouble. Our population has already reached an uncomfortable level, at which it is extremely difficult to provide adequate food, clothing and housing. Millions of us live in a state of semi-starvation. There is considerable distress all over the country. A further increase will make things very much more difficult. It may even reach a breaking point when it will no longer be possible to maintain any law and order. The consequences should be envisaged by all who have the interests of the country at heart.

The State should face the issue and organise a nationwide effort in the form of free advice and assistance in controlling the population. It may take some time for the effects to be felt but we will be steadily warding off the other inevitable crisis

STATE INITIATIVE NEEDED FOR TACKLING THE POPULATION PROBLEM

The food problem of the country cannot be altogether dissociated from the population problem. Jointly they constitute the biggest problems before the country today. They have profound influence on all the social, political and economic problems before the country. They require, therefore, the unanimous and whole-hearted attention of the State authorities. With an organised nationwide effort, the country can look forward to a future: otherwise the outlook would be very gloomy. Hunger will break all barriers of organised human society and the whole of the State machinery will collapse India is now practically an independent nation, but the freedom will be worth nothing if we are to live in a state of abject misery, without adequate food, clothing or shelter.

WILLIAM CAREY (1761-1834)*

WILLIAM CAREY was born on the 17th August, 1761, at a village, Pauler's Pury in Northamptonshire. His father was originally a weaver and later a teacher in a village school and clerk in a local parish. From his father William Carey imbibed an intense desire for knowledge in various branches of arts and sciences. He was specially interested in History, Geography, Travel, and in Natural History.

From the age of 12 (1773), Carey had to make efforts to earn a living. At first he was apprenticed as a hand-loom weaver, and later at Piddington to agriculture, but it did not suit his health. So in 1775 he had to take up the profession of shoe-making which was becoming the chief craft of the country and continued in this profession till 1786. During this period, he learnt several languages—Dutch, Italian, French, Latin, Greek, Hebrew,—and also read religious books, classics, text books of science and history and *Periodical Accounts* of the Baptist. In 1786, he became a teacher in a school at Moulton, and also served in the pastorate at Moulton (a village) and Leicester (a town). By 1780, he became a clergyman and began lay preaching. On October 2, 1792, 14 obscure men met at the house of William Carey at Kettering and formed the 'Baptist Missionary Society'. Carey soon after conceived the idea of taking the message of the Bible to India. The first of a notable succession of missionaries, Carey also became famous as a linguist and an educationist in India.

Columbus' account of the discovery of America and Captain Cook's voyage in the 'Endeavour', infused in Carey's mind a desire for an adventurous career. In Cook's records, he became interested in adventure, seamanship, exploration, astronomy, art and botany.

Escorted by John Thomas (the first baptist missionary to arrive in India in 1783, as a medical attendant of the East India Company's fleet), Carey (age 32) set out for evangelistic work on June 13, 1793, from Dover by 'Princess Maria', a Danish ship. Thomas had by this time twice visited Bengal, settled at Malda and Calcutta, could read and speak in Bengali and even sojourned for sometime at Nabadwip (the birth place of Chaitanya) for studying Sanskrit. During his voyage, Carey learnt Bengali from Thomas and landed at Balasore on the 7th November, 1793, arriving in Calcutta on the 9th November, after 5 months' voyage. Thomas and Carey were thus the first Englishmen to voyage to India (or Asia?) for sheer love of Asia and of Christ.

From Calcutta, accompanied by Ramram Bose (who was employed as Carey's *moonshee*), Carey moved on to Bandel, Nadia and finally to Debhatta in the Sunderbans. It is said that he was pursued by the agents of the East India Company,—who tolerated no missionary activities within their domain,—and in fact Carey was sheltered for a while by Niloo Dutt of the Rambagan Dutt family in his garden house at Manicktola. While at Bandel, Carey got the information that the East India Company had been looking out for a person with knowledge of botany to superintend the Company's garden at Sibpur. Captain Christmas interviewed the official chief, showed him a botanical monograph of Carey and convinced him of his fitness for the appointment. Carey went to Calcutta, but found

* Full text of a talk entitled 'Carey as a Botanist' given by Mr A. K. Ghosh, Honorary Secretary, Botanical Society of Bengal, on the occasion of the anniversary of the foundation of the Royal Agri-Horticultural Society of India, held on the 15th September, 1947, at the Society's premises, 1, Alipur Road, Calcutta. Mr A. P. Benthal, President of the Society, presided.

the situation disposed off already. William Roxburgh had stepped up before him and was appointed to the post. It so happened later that Roxburgh and Carey became great friends and co-workers in being offered by Ramram Bose's uncle) and acquiring knowledge of local plants, birds and insects. About this time his name was mentioned to the Government for a botanizing quest to Assam and

William Carey and Ramgopal Nayalankar (*alias* Gopal Nayalankar). The latter acted as Carey's amanuensis.
Photo: After Robert Home.*

Indian Botany, and Roxburgh's pioneer work on India's flora is known to us today due to the efforts of William Carey.

From February, 1794 to August, 1794, Carey remained at Sunderbans, doing land tillage (land Tibet;—then he was appointed Manager of Indigo manufactories, with the fair and fixed salary of Rs. 200/- per month, at Madanabattee (32 miles north of Malda) where he remained up to the end of December, 1799.

By 1795, Carey had acquired a good grasp of the Bengali language and could read and speak in Bengali with ease. He began preaching to the

* Our thanks are due to Rev. D. S. Wells, Secretary, Baptist Missionary Society, Calcutta, for the loan of the block of this photograph. *Ed. Sci. & Cul.*

numerous employees in the Indigo factory and taught them to grow better roots, fruits and cereals. He also introduced garden and flowering trees, seeds, fruits, field and forest trees from abroad. One of his constant donors in India was Matthew Smith, superintendent of the 'Botanic' at Sylhet. His frequent tours over the district of Dinajpur gave him opportunity to get a masterly knowledge of the flora and fauna of the district and of the contiguous parts of rural North Bengal. He often advised people on the prospects of growing jute and other crops in North Bengal. In 1795, Carey visited Bhutan and hunted new plants. He visited Bhutan for a second time in 1797. 24 plant kinds including a new species *'Careya'* from Bhutan were presented by Carey to Roxburgh, who reciprocated these gifts. Carey also furnished Bengali names of plants to Roxburgh, who in turn gave Carey botanical names whenever asked for.

Amidst all these scientific activities he was no less busy with his literary work. By the end of 1796, the whole of New Testament was translated and a Bengali grammar and dictionary compiled by Carey. He had now to find out ways of printing the New Testament, for which printers at Calcutta demanded Rs. 40,000 for 10,000 copies. In the meanwhile life at Mandanabatte was not very happy and easy. The work on Indigo was practically stopped due to alternate flood and drought for two successive years, and the factory ultimately was closed in 1799.

In 1797 (December), a letter foundry was set up in Calcutta for Bengali and other vernacular languages, and soon after a wooden press arrived from England, and Carey secured this for £45 with the help of Mr Udney (owner of Indigo factories) and brought it to Madanabattee in September, 1798. Specimens of Bengali letters for types for the printing press were also sent by Carey to England, and Indian printers were engaged to run the press and do the compositors' work. With the close of the Indigo factories in 1799, Carey started a new establishment at Kidderpur (10 miles from Madanabattee), with his savings amounting to Rs. 3,000/-. In the same year a proposal made by Carey to set up the printing press at Maldah (or even anywhere beyond Calcutta) was peremptorily refused by the Governor-General, Marquess of Wellesley, for reasons of State.

On October 13, 1799, a second batch of baptist missionaries, *viz.*, Marshman, Ward, Brunsdon, and Grant arrived in Calcutta, but failing to find any shelter, as the British authorities forbade their dwelling in the Company's domain,—they went to the Danish settlement at Serampore. They were later joined by Carey, who left Madanabattee on the 25th December, 1799, leaving behind all his assets excepting the printing press and his multitude of precious plants which he had collected between 1793-1799. 427 species of plants were listed by Carey as growing in his Serampore garden in June 1800, all brought from Madanabattee. Carey arrived at Serampore on the 10th January, 1800, and from this date missionary activities commenced at Serampore. Ward, Brunsdon and Carey's son (Felix Carey) took up the work connected with the press. The press was set up, letters brought from Calcutta, and with the help of Indian compositors, printing of the Bible commenced and the first book in Bengali, *viz.*, Carey's translation of "A letter to the Lascars", was published from 'Serampore press'* in August, 1800. On February 12, 1801, Bengali New Testament was published. This is preserved at Serampore College Library. Carey thus earned the gratitude for preparing letters in Bengali and other Indian languages for the press.

Soon after on the 24th November, 1800, the Marquess of Wellesley, who founded the Fort William College in Calcutta (where the writers† of the East India Company were taught the chief Indian languages and literature, history, etc.) attracted by Carey's linguistic and literary abilities invited him to be the teacher in Bengali, Sanskrit and Marhatti in the college, on a salary of Rs. 500/- per month. Carey took up the appointment on the 4th May, 1801. The revival and improvement of the Bengali language really commenced at Fort William College by *Pandits* (Mritvunjov Vidyalankar, one of India's best Sanskrit scholars, Ramram Bose, Rajiblochan Mukherji, Golaknath Sarma and others) under Carey, through whose liberality and great exertion many works were carried through the press and the tone of the language of the province greatly raised. According to Dr S. K. De, "To Carey belongs the credit of having raised the language (Bengali) from its debased condition of an unsettled dialect to the character of regular and permanent form of speech, capable as in the past, of becoming the refined and comprehensive vehicle of a great literature in the future." "Carey was the centre of the learned Bengalis whom his zeal attracted around him. The impetus which he gave to Bengali learning, is to be measured not merely by his production and his educational labours, but by the influence he exerted and the example he set. His college rooms became the centre of literary activity. The best intellects and scholars of the country met in friendly inter-

* The present Baptist Mission Press, Calcutta, inherits the traditions and carries forward the achievements of the world famous 'Serampore Press' founded by Carey, Marshman and Ward in 1800. W. H. Pearce, who came to Serampore in 1817 and was associated with Ward, himself a printer, opened a press in Calcutta on the Serampore model in 1818. These two presses were amalgamated in 1837.

† They were designated as 'Writers of the Company' and hence the building where they lived is known as "Writers' Building".

course at Fort William and Carey drew around him a band of enthusiastic writers bent on removing the poverty of their languages".

Thus the beginning of the 19th century has been the formative phase of the modern Bengali Prose literature. Whatever has been written during this period has been either instructive, informative or discursive. The missionaries at Serampore headed by Carey and the *Pandits* under him are responsible for both instructive and informative phases by translating from English into Bengali. The *Pandits* similarly translated from Sanskrit into Bengali, while the third phase that of discursive is due to the efforts of Raja Ram Mohun Roy. "Carey was the pioneer of the revived interest in the vernaculars" said Rabindranath ; he is thus rightly given the primal place in India's modern literary development.

Towards the end of 1806, Haileybury College was established at London for the training of India's civil servants, and the staff at Fort William College reduced. But from January 1, 1807, Carey became Professor of Bengali, Sanskrit and Marhatti languages at this College, on a salary of Rs. 1,000/- per month, and he continued in this College till 1831, when he was pensioned off at the rate of Rs. 500 p.m.

During this period he wrote a Bengali grammar (1801), Bengali text books (including the *Ramayana* and the *Mahabharata* (1802). Besides he edited and published grammar and dictionary in Sanskrit, Marhatti, Oriya, Assamese, Punjabi and Canarese, and translated the New Testament and the Old Testament into 34 different Indian languages. But his greatest achievement was the "Dictionary of the Bengalee language", in which 3,000 Bengali words are traced to their origin and their meanings given in 3 volumes (1815-25). His scientific acquirements and conversancy with the subject of natural history qualified him to employ characteristic denomination for the products of the animal or vegetable kingdoms peculiar to the East. It has been suggested by some, that being the head of the missionaries at Serampore and Fort William College, Carey appropriated for himself the entire credit for this Herculean work on various Indian languages, but contemporary history disproves this allegation.

In 1805, the Asiatic Society of Bengal allowed a stipend of Rs. 300/- per month to Carey for scientific and other writings in Sanskrit to be translated into English. Carey became a member of this Society in 1806 and met Calcutta's most catholic intellectuals. The *Ramayana* was translated into English by Carey and 3 volumes published between 1806-1810. Carey was also appointed Bengali translator of the Bengal Government on a salary of Rs. 300/- per month in 1824. The post was abolished in 1830. He translated among other Sir William Jones' 'Digest of Hindu Law' and became a botanical friend of both Sir William Jones and Raja Ram Mohun Roy.

The Government thwarted the mission's activities in 1805 and again in 1806, 1807 and 1812. Sir George Barlow (Acting Governor-Geenral in 1805) stopped open preaching and distribution of literature and even demanded transfer of the press to Calcutta. Preaching was later allowed around Serampore colony but not in the open and least in 'Lall Bazar'.

In March 1812, a large fire consumed all the printing office, excepting the press and the paper manufactory involving a loss of Rs. 70,000 ; a large number of manuscripts were lost which no money could replace including portions of all Indian scripture versions, Canarese New Testament, Old Testament books in Sanskrit, many pages of his Bengali dictionary, Telegu grammar, Punjabi works, portions of *Ramayana* and dictionary of Sanskrit and allied tongues. But within 12 months the loss was fully repaired.

At about this time (1818) a college was founded at Serampore by the Rev. Drs. Carey and Marshman and William Ward. Carey's ideal was that though a Christian College, creed, caste or colour would not be a bar to one's admission in that institution. The King of Denmark, Fredrick VI, conveyed a large house and ground belonging to His Majesty to Carey for the College. The College obtained a Danish Charter in February, 1827, giving perpetuity to the institution and its endowments and empowering it to grant degrees in all faculties. It is still the only College in India with power to confer Divinity Degrees. The College was later one of the 8 colleges affiliated to the Calcutta University in 1857. The college building, erected in 1818 by Dr Carey and his colleagues, still remains one of the finest college buildings in India. The "College House", at one time occupied by Dr Carey, now provides accommodation for the professors. Dr Carey remained Principal of the College from 1818-32. Besides, he established at Serampore a network of free vernacular schools for boys and girls and a model agricultural farm for imparting instruction in scientific agriculture to the cultivators.

The science of Botany was his constant delight and study. He subscribed Curtis's monthly *"The Botanical Magazine"*.* Surrounding, adorning and completing the college was Carey's amazing five-acred botanic garden—the finest then in the east,—

* The *"Botanical Magazine"* founded by William Curtis, (bicentenary of whose birth was celebrated on Jan. 12, 1946) is one of the earliest botanical journals; its publication has not been interrupted since its appearance in 1787, and is one of the world's foremost periodicals. (See *Endeavour*, January, 1947, p. 13).

and his fondness for his garden remained to the last. Its plants, shrubs, flowers, fruits, trees, groves, tanks, conservatories, aviaries, etc. together with the museum within the college were admirable. His collection of mineral ores and other objects of natural history was extensive. The arrangements made by him were on the Linnean system, and the garden contained rarest botanical collection of plants in the east; to the extension of which, by his correspondence with persons of eminence in Europe and other parts of the world, his attention was constantly directed and in return he supplied his correspondents with rare collections from the east. 'Many plants to be found in Bengal today came of seeds first bird-borne or wind-sown from Carey's garden'.

The Serampore garden was then, in Carey's time (and later during Voigt's day) almost as important as the botanic garden at Sibpur, and worked hand in hand with the latter institution. Thus it was Dr Carey, and not the Hon'ble Company, who in 1814 undertook the task of editing and publishing Roxburgh's (Superintendent, Royal Botanic Garden, 1794-1813) *Hortus Bengalensis* (or a catalogue of the plants growing in the Hon'ble East India Company's Botanic Garden at Calcutta) after Roxburgh left India in 1913, in which are catalogued the 3,500 species in cultivation in the Royal Botanic Garden between 1786-1814, of which a large number was introduced by W. Carey between 1796-1813 (and some by his son, Felix Carey) from various parts of Bengal that he visited during his missionary itineraries, (incuding Sunderbans, Terai and Bhutan), and also from Levant, Europe, W. Indies, Cape of Good Hope, Pegu, China, N. America, Arabia, Iran, Barbary, Malacca, etc. It is on this valuable work, which, but for the existence of the Serampore Garden, we should never have possessed, that Voigt's larger one was based. The publication of this *Hortus Bengalensis* helped Roxburgh to secure priority for many of his species.

In his introduction to *Hortus Bengalensis*, Carey has dwelt on the status of the Sibpur Botanic Garden during this time and indicated lines along which the garden should be developed. He specifically mentioned the utility of improving the culture of grains through the efforts of an agricultural society and as a substitute for the society he advocated the attachment of an Experimental Farm to the botanical garden at Sibpur, and also establishment of regional botanical gardens in different parts of India. Carey's interleaved copy of *Hortus Bengalensis* is kept in the Baptist Missionary Society's library.

Roxburgh's eventual successor at Sibpur was the young Nathaniel Wallich, Serampore's Danish Surgeon. Carey's letters to Wallich are indexed with dates in Wallich's ledger of his correspondence and were indeed instructive to the latter. Carey was engaged for several years in the publication of Roxburgh's *'Flora Indica'*, in concert with Wallich, (Superintendent, Royal Botanic Garden, 1817-42).* Two volumes of this work appeared based mainly on Roxburgh's detailed work containing descriptions of all the new plants which he had discovered, as well as notices of those which, though previously described, he had found in India. The manuscript of this work was deposited with Carey. A portion of this work, extending to *Pentandria monogynia* with the invaluable additions of Dr Wallich, and Dr Carey's Sanskrit synonyms were published in two volumes in 1820 and 1824 with a preface by Dr Carey. Wallich repeatedly acknowledged Carey's services and whenever in doubts, he used to consult Carey to confirm his botanical identifications (see *Plantae Asiaticae Rariores* by Wallich, 1830). As this volume of the work has been long out of print and not completed, and as the sons of Dr Roxburgh were anxious that the *Flora Indica*, on which Roxburgh bestowed so many years of unremitting labour, should be presented without any further delay to the scientific world, Dr Carey, at their request edited and superintended the progress of Roxburgh's *Flora Indica*, published in 3 octavo volumes at Serampore in 1832.†

Carey's Botanic gardens presented Voigt (Surgeon to Danish Government, Serampore) advantages that led him to the study of Botany and his intercourse with this great man (Carey) was a source of abundant encouragement to him. Besides the garden furnished a rich and varied information.

Voigt's Hortus included the entries in Carey's *Garden Receipt Book*, so that it dealt with all plants that had lived at Serampore, but had succumbed at Sibpur, and all plants introduced at Serampore between 1814-34. Several of these were obtained not by Voigt but by Indian collectors sent by Carey or by Voigt himself.

After Carey's death (1834) Voigt superintended the Serampore garden from 1834-43.‡ He felt it his

* "So competent a botanist was Dr Carey acknowledged to be, that he was put by the Local Government in charge of the Botanic Garden, when Roxburgh was obliged to leave it; and he continued to hold charge of it until relieved by Dr Buchanan-Hamilton, who was nominated its Superintendent by the Court of Directors in England." Roxburgh left India in 1813 and Buchanan-Hamilton joined in 1814. So Carey's office of Superintendentship was for about 6 to 12 months.

† This edition having been for many years out of print and difficult to purchase, a verbatim reprint of it in one volume was undertaken by C. B. Clarke, F.R.S., which appeared in 1874. The main object of this edition was to put the book within the reach of the poorest Indian student (price Rs. 5/-); it remained the standard work on systematic botany in India for the whole of the 19th century.

‡ Voigt also acted for sometime as Superintendent, Royal Botanic Garden, Sibpur, when Wallich went on leave in 1842.

city to place on record the results of the botanical labour of Carey extending for more than 30 years. This was accomplished by 1841, when the manuscript was made over to the *Agricultural and Horticultural Society*, who generously engaged to defray the expenses of the publication. Obstacles, however, arose to the acceptance of Society's offer and printing was suspended. Voigt left India with the manuscript, and died on 22-6-1843. The work was later seen through the Press successively by Dr William Griffith, Superintendent, Royal Botanic Garden, (1842-44) and John Mack of Serampore College. The scope of the work is indicated by its title:

"*Hortus Subarbanus Calcuttensis*: A catalogue of the plants which have been cultivated in the Hon. East India Company's Botanical Garden, Calcutta, and in the Serampore Botanical Garden, generally known as Dr Carey's garden, from the beginning of both establishment (1786 and 1800) to the end of August, 1841: Printed at the Bishop's College Press, 1844."

In recognition of his knowledge of natural history, the most fitting tribute was paid to Carey by Roxburgh in creating a genus named after him, *viz.*, *Careya Roxb. (D. C. Pr.: 3, p. 205: W. & A. Pr. 1, p. 1334)*.

Carey frequently gave lectures on Botany, which were well attended and never failed to prove interesting. He encouraged the study of science, whenever a desire was manifest. He had completed other works on natural history of India and specially on Ornithology, with which view he formed a collection of birds, so that he might observe their living habits. But his other duties, literary pursuits, prevented him from doing this.

For sometime past, Carey had at heart the idea of forming an agricultural society in India, and he had a talk with Lady Hastings upon the subject, who encouraged him to make an attempt. Later a prospectus was prepared by Carey and issued throughout India on April 15, 1827. A study of this prospectus gives an insight into Carey's knowledge in agriculture; and he suggested improvements on various lines, and means recommended for achieving these were:

1. Collecting information on the innumerable subjects connected with the agriculture of the different parts of the country.
2. Enhancing the value of land by improved modes of culture, manures, rotation of crops, draining, embankments, etc.
3. The introduction of new and useful plants.
4. The improvement of the implements of husbandry.
5. Improving live-stock.
6. Bringing waste lands into a state of cultivation, etc.*

* The programme still remains to be fulfilled.— Ed., *Sci. & Cul.*

In regard to horticulture, Dr Carey said, "It is also known and lamented that the state of horticulture in this country is almost as low as that of agriculture; so that, except in the gardens of certain Europeans, who at a great expense procure a few articles for the table, there is nothing to be met with, besides a few wild herbs, or garden productions of the most inferior kind. All that is seen of orchards, amounts to no more than clumps of mango trees crowded together, without judgement, and in which the quality of the fruit is little considered. The improvement of fruit is almost neglected, and everything which can contribute to the furnishing of our tables with wholesome and agreeable vegetables and fine fruits, is yet to be commenced; not to mention that ornamental gardening is scarcely known." This picture was drawn in 1820.

32 persons responded approving and promising to join the Society and so a meeting was called on the 14th September, 1820, in the Town Hall, Calcutta, and was attended by 7 persons including Raja Vaidyanath Ray, and Sri Ramkamal Sen (Carey's Fort William College colleague). An *'Agricultural Society of India'* was formed, which had 50 members in a month's time. Carey and Ramkamal Sen were the first secretaries. Carey was elected a President of the Society in 1824-26 (when the President W. Leycester went on leave). The Marquess of Hastings became its first patron. A portion of the land close to the botanics at Sibpur was given to the Society. In 1826 its name was changed to the *Agricultural and Horticultural Society of India* and in 1935 *Royal Agri-Horticultural Society of India*. In 1827, land in Alipur was leased and given to the Society for horticultural developments. From 1836-1872 the society's garden was situated close to the Sibpur Botanic Garden; then it was transferred to its present site in Alipur. At a meeting of the Society held in March 1827 Carey was requested to draw up a letter stating the objects of the Society and a questionnaire issued to persons interested in agriculture and horticulture. Useful data were collected in reply to these from both Indian and European residents of India, and these are printed in the *Transactions of the Society* (1837).

When Carey started the Society he found that the cereals, the vegetables as well as the fruits of the country, were very poor in quality, and he immediately interested members of the Society in his scheme to import seeds from all parts of the world for free distribution. Sugarcane from Mauritius and other sources was obtained and propagated for free distribution. Capt. Sleeman received the Gold Medal of the Society in recognition of his experimentation on and introduction of foreign canes. Cotton seeds from America, tobacco seeds, and seeds of some other

crops of improved varieties were also obtained for free distribution, and medals and prizes were offered for the introduction and improvement of the crops. Exhibitions were held in Calcutta annually shortly after the seeds were distributed and large monetary prizes and medals were awarded for the best growers of vegetables as well. In 1828, 109 *malis* competed for the prizes. Essays on various subjects were written at the instance of the Society and generous rewards given to the best authors.

The Government of Bengal co-operated with the Society and provided funds and an experimental farm (of 500 bighas) was established in 1820 at Akra, several miles from Calcutta.

Branch societies were formed in Lucknow, Western India, Madras, Dinapore, Bangalore, Birbhum, Burdwan, Hooghly, Dacca, Meerut, and as far as Singapore.

Experiments were conducted by its members in growing staple products, cereals, etc. But the demands for more elaborate experiments were impossible to meet with the help of the small staff and land at its disposal, and hence Lord Curzon relieved the society of all agricultural work. The Government grant was stopped and since then the Society is self-supporting with a membership of about 1,200.

For the past quarter of a century there has been call for a better layout of gardens by both Europeans and Indians and the Society is principally interested in horticulture.

In the past the Society, published *Transactions* and *Journal,* maintained a Museum, constituted standing committees for various economic crops, made efforts for the improvement of cattle, maintained a school for training gardeners, and published Bengali translation of its *Transactions.*

Thus it was this Society that did pioneer work for the improvement of India's agriculture and not the Company's Government. Carey was an active member of the 'Agricultural and Horticultural Society'. On the 3rd May, 1832, he communicated a paper entitled 'On the method of manufacturing paper in India.' His notes along with those of Ramkamal Sen were transmitted to the Government.

As far back as 1820, Carey installed a steam engine in the paper mill attached to his press at Serampore. Later, this was followed by a Fourdrinier Paper-making Machine, at that time a comparatively new invention and the first to be installed in this part of the world. The first paper-making machine in India was thus set up by Carey and with its help he introduced paper manufacture on a large scale.

For many years and up to his death, Carey was one of the active members of the 'Asiatic Society of Bengal'* and afforded considerable information and in various ways promoted the general interests of the institution. He furnished a few instructive papers to the '*Asiatic Researches*'. His paper entitled "Remarks on the state of Agriculture in the district of Dinajpur" describing the district's soils, modes of tillage, and the remediable poorness of its cereals and of its roots and fruits in stock, is the result of the sustained labour and experience, he gathered during his stay in that district. A second paper entitled "An account of the funeral ceremonies of a Burman priest" was also contributed by him.

A representation being officially made to the Government in 1822, that the scarcity of timber was such that it was feared there soon would be great difficulty in supplying the wants of the commissariat, Carey was appointed in 1824, a member and secretary of the committee to enquire into and take measures for remedying the risk. This was called the "Plantation Committee", and it considerably added to his labours. The committee laid out plans for planting new forests, and preserving the old ones and the plans were carried into effect with the assistance of the Government. This is the earliest known plan in India for *afforestation*

On March 8, 1807, the University of Brown (U.S.A.) conferred upon Carey the degree of the doctor of divinity. Later, he was awarded the Danish Order of Dannebrag which he had to decline as not in keeping with their mission character and work. In 1823, Carey was elected Fellow of the Linnaean Society of London, member of the Geological Society of London and a corresponding member of the Horticultural Society of London.

Carey was the first Editor, from May 1818 of *The Friend of India* which was first published as a monthly and then as both monthly and quarterly for several years at Serampore. The paper was later incorporated with *The Statesman.* Simultaneously with the "Friend of India", a monthly vernacular magazine, the *Digdarshan* (April 1818) and also a weekly newspaper the *Samachar Darpan* (1818, 23rd May) were published mainly due to Carey's efforts. The monthly was Bengal's first and the weekly its second.

By his will, Carey bequeathed to the Serampore College, the whole of his museum, consisting of minerals, shells, corals, insects and other natural curiosities and a *Hortus siccus,* also the folio edition of *Hortus Woburnensis* which was presented to him

* Carey was also elected Chairman of two sub-committees, *viz.,* Horticultural Committee and Committee of Papers; and a member of the Agricultural Committee of the Asiatic Society of Bengal.

by Lord Hastings. He further directed his funeral to be as simple as possible with the inscription:

"Willian Carey, born August 17, 1761, died

. . . .

"A wretched, poor and helpless worm
On Thy kind Arms I fall."

From 1828, Carey's health broke down and he died on June 8, 1834, and was buried at Serampore with a tomb bearing the inscriptions quoted above.

The Asiatic Society of Bengal recorded the following tribute of their respect to his memory,—the resolution being moved by the Bishop of Calcutta, "The Asiatic Society cannot note upon their proceedings the death of the Rev. William Carey, D.D., so long an active member and an ornament of this institution, distinguished alike for his eminent services in opening the stores of Indian literature to the knowledge of Europe, the natural history and botany of this country, and his useful contributions in every branch towards the promotion of the objects of the Society, without placing on record this expression of their high sense of his value and merit as a scholar, and a man of science; their esteem for the sterling and surpassing religious and moral excellences of his character; and their sincere grief for his irreparable loss".

At a meeting of The Agricultural and Horticultural Society of India, held on the 18th June, 1834, at the Town Hall, a resolution moved by Dr Nathaniel Wallich, recorded with sentiments of deep regret "the irreparable loss which the Society has sustained by the death of their late venerable and respected Vice-President, the Revd. William Carey, to whom as its original founder, the Society owes its very existence, and to whose unremitting and valuable co-operation in the several capacities of Secretary, Vice-President and President, much of the good which it has been able to effect is absolutely due".

It may be of interest to note that William Carey and his colleagues, with the deepest interests of India in their hearts, formulated a series of resolutions in what is known as the 'Serampore Covenant of 1805', containing inspiring message for all classes and communities which every party in this country might practise, and which every foreigner should exercise. Here are some of them:

To set an infinite value on the individual soul
To esteem and treat Indians always as our equals
To abstain from whatever deepens India's prejudice
To engage in every work that is for India's good
To be instant in the nurture of personal religion
To give ourselves without reserve not counting even the clothes we wear our own.

Willian Carey was the man. Being dead, he yet speaketh.*

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* My thanks are due to my former pupil, Mr M. K. Datta, Assistant Secretary, Royal Agri-Horticultural Society of India, for helping me in various ways, in preparing this note.—*A. K. G.*

SIR EDWARD APPLETON

NOBEL PRIZE WINNER IN PHYSICS, 1947

THE award of the Nobel Prize for Physics to Sir Edward Appleton will delight all who have known of his fundamental contributions to the science of radio and to its applications. It has been amazing how Sir Edward or, to call him by his more familiar name—Appleton, has made use of radio waves as a tool for investigating such diverse geophysical phenomena as, weather fronts, storm centres, magnetic field intensity high above the surface of the earth (300 km.), atmospheric tides at high levels, detection of meteor trails, as also, emission of these waves from the sunspot regions and from the milky way.

But to the non-specialist Appleton is perhaps best known for his work on the elucidation of the nature of, and of the radio wave propagation phenomena in the ionized regions of the upper atmosphere known as ionosphere. It was in 1904 that Kennely in America and Heaviside in England propounded

SIR EDWARD APPLETON

the hypothesis that radio waves are guided round the curved surface of the earth by being reflected from a conducting ionized region in the upper atmosphere. The hypothesis was considered very plausible but a direct proof as to the existence of the conducting region was lacking for a long time. The proof was first furnished by Appleton with his associate Barnett in 1925 when they observed that radio waves from a distant station arrive by two distinct paths, one direct—moving along the ground (ground wave) and another indirect—reflected from the high ionized region (sky wave). Very early in his study on ionosphere Appleton made the remarkable discovery—a fact which is now taken almost for granted but which at that time was by no means obvious—that the ionosphere was stratified, as it were, into a number of layers. The uppermost layer which is the most intensely ionized is named after him 'Appleton layer'. Appleton, however, modestly refers to it as the F-layer and the one underlying it at 100 km. he called the E-layer. Once he was asked why he chose the letters E and F instead of the more obvious ones A and B. And he replied this was to leave room for undiscovered layers below the E-layer! His surmise proved correct; an absorbing ionized region which causes weakening of radio signals has been found below the E-layer. This is called D-layer. Appleton was also the first to point out that the magnetic field of the earth will have a profound influence on the propagation phenomena of the radio waves through the ionosphere. He developed the so-called magneto-ionic theory and showed how the propagation properties (refractive index, polarization, absorption) are related to the magnetic field intensity and the intensity of ionization in the ionosphere. All the consequence of the magneto-ionic theory are fully borne out by observations. It can be said without exaggeration that it is to Appleton, more than to any other single individual, that we owe our present knowledge of the ionosphere.

The development of radar which has revolutionized modern warfare also owes much to Appleton's work. As a matter of fact, the principle of the estimation of the height of ionospheric layer is a kind of radio location, the difference being that the object to be located by radar is a body of much smaller extension like aeroplane. The amount of the incident radio wave energy which such a body returns by scattering is necessarily very much smaller than that by the ionosphere. The problem of making an estimate of the energy is extremely important in the design and development of radar apparatus. Appleton's work has done much to clarify this problem. From his investigations in this subject Appleton was able to predict that it would be possible to obtain radar echoes from the moon.' This, as we all know now, has already been achieved.

Sir Edward is a great organizer. The Department of Scientific and Industrial Research of England is fortunate in having him as its chief executive head.

About three years ago, when the war was still on, the author of this note had the opportunity of attending in England a meeting of the Ultra-Short Wave Panel of the Ministry of Supply. The body had been set up by Sir Edward and he humorously described it as his own child. He had collected round him in this Panel about two dozen specialists physicists, mathematicians, meteorologists, radio-technicians, electrical engineers and spectroscopists to work on problems associated with the propagation of micro-waves through terrestrial atmosphere close to the ground. Each was assigned an aspect of the problem in which he was an expert. The results obtained by the different workers when collated ensured quick progress and success in the shortest possible time. It was pleasant to see how these experts—some of them of internatonal reputation—worked together as a single team under the guidance of Sir Edward.

Sir Edward's great talent for organization was also utilized by the British Government in scientific war effort. Sir Edward was appointed a member of the Scientific Advisory Committee of the War Cabinet in 1941 and the main burden of organizing atomic research in England devolved upon him. He established the 'Directorate for Tube Alloys' (a camouflage name) under the Department of Scientific and Industrial Research. The Directorate planned and conducted researches on controllable nuclear chain reaction in all its aspects with the ultimate object of utilizing the results in atomic explosions. Under the supervision of Sir Edward, the Directorate made notable contributions to the development of atomic bomb.

Sir Edward was born in Bradford, Yorkshire and is now 55. He held successively professorial chairs of Physics in King's College, London and in Cambridge. On the retirement of Sir Frank Smith in 1939, he was appointed Secretary to the Department of Scientific and Industrial Research, which post he still holds.

Sir Edward is an original thinker of rare ability. He has an intuitive mind and is gifted with a penetrating insight which enables him to get straight at the root of a problem. He is known personally to many scientific workers of this country and is in constant touch with the ionospheric investigations here. Sir Edward lent his services, on more than one occasion, to the University of Calcutta for examining doctorate theses.

S. K. M.

PROBLEM OF SEED POTATOES

H. C CHOUDHURI,

SPECIAL OFFICER (POTATOES), DIRECTORATE OF AGRICULTURE, WEST BENGAL

THE potato is an important food crop in all the countries of the world. It can presumably be said that no other food crop is capable of yielding so much popular food per acre. Thus for example, rice and wheat on the average yield 9·9 to 9·0 mds. per acre, respectively whereas the average yield of potatoes per acre is 109 mds. The improvement and efficient management of the potato crop is, at any time, a matter of great importance, since it can go a long way in substituting the essential food stuff in times of crisis.

The quality of seed tubers like the seeds of any other agricultural crop is an important factor to increase the production. It is an undenying fact that improved disease-free seeds can give an increased yield per acre provided other factors for cultivation are ideal, *viz.*, climatic and soil conditions, manuring and irrigation.

In Bengal, the seed potatoes are largely imported from other provinces, *viz.*, Burma (before the war), Assam, Punjab and Bihar. It may be mentioned in this connection that a fair proportion of seed potatoes coming from the hills of Darjeeling are seeds actually imported from Nepal. In Table I is shown the quantity of seed potatoes imported to Bengal.

TABLE I

Province and States	Quantity* (in mds.)	Remarks
Punjab	1,67,260	
Assam	1,00,000	
Bihar	55,000	
Darjeeling	43,000	
Burma	70,000†	Approximate.
Nepal	80,000‡	Approximate.

* Import figure for 1946.

† Recent figures not available as import of potatoes from Burma was stopped since beginning of war in the East.

‡ These seeds come *via* Darjeeling and a proportion of it is used for hill-cultivation in the District of Darjeeling.

The serious shortage of seed potatoes felt in recent years in various parts of our country may have been due to the following reasons: Firstly, the increase in acreages under potatoes has not been preceded by increase in yield of seed potatoes per acre. Secondly, increased acreages under the crop has not been followed by appreciable increase of production owing to degeneration of seed potatoes and loss of crop in the field owing to increased incidence of various diseases and pests. Thirdly, the stoppage of supply from Burma.

It is very likely that even if the supply from Burma is resumed the strained supply position of various types of seeds may not be eased to the extent one would imagine. The reason, of course, for such an assumption is stated before.

It is well-known that successful production of potatoes depends to a large extent on healthy disease free seeds. So far no serious attempt has been made to maintain healthy stock seeds on a scientific basis The consequence is that the farmers are unfortunately using these diseased seeds year after year resulting in decreased yield per acre.

Seed Growing District

It is well-known that potato is a cold climate plant that grows well in cold regions. Moreover, the incidence of *aphis* which transmits most of the viruses excepting virus-X, infest the crop in lower altitudes than on altitudes on or over 6,000 ft. The District of Darjeeling, where the altitude varies to a great extent from area to area, has been found to be the only suitable area in Bengal for production of seed potatoes of high quality, provided the modern methods for production of disease-free seeds are applied.

There is hardly any reliable figure for acreages under potatoes for the District of Darjeeling. But it is presumed to be in the neighbourhood of 2,50[illegible] acres. Total production, the quantity preserved f[illegible] seeds and the total quantity used for internal co[illegible]sumption is shown in Table II.

TABLE II*

Growing area	Acreages	Quantity preserved for seeds (in mds.)	Quantity used for internal consumption (in mds.)	Quantity exported (in mds.)	Total production (in mds.)
Darjeeling	2,500	30,000	80,000	40,000	1,50,000

* The figures are to be considered approximate. The data do not include the quantity which is imported to the district from Nepal.

Commercial Varieties of Potatoes

There is hardly any classified list of commercial varieties cultivated in our seed growing district. The growers as well as the consumers are very much in confusion as they hardly know the distinction of one variety from the other and this is much more intensified by the mixture of one variety with the other The consequence of such ignorance is that none of the varieties in cultivation exist in pure state and they are all inter-mixed with one another. Careful examination of samples collected from different parts of Darjeeling revealed four distinct types. Table III shows some of the important diagnostic characters of them.

TABLE III

Variety	Shape of tubers	Sprout colour	Skin colour	Flesh colour	Cooking quality	Maturity	Depth of eyes
Red Round	Round	Red-purple	Red-purple	Yellow	Starchy	Early	Medium
White Round	,,	,,	White	White	Waxy	,,	,,
Great Scot	Oval	White	,,	Yellowish white	Starchy	Main crop	Shallow
Nainital*	,,	Blue-purple, Red-purple / white	,,	White	,,	,,	,,

* It is not a variety by itself but a mixture of different varieties, *viz.*, Magnum Bonum, Royal Kidney, up-to-date and Great Scot.

Varieties cultivated in Different Areas

It has been stated before that the potatoes are grown all over the District of Darjeeling but some areas seem to be more suitable for cultivation of certain varieties of potatoes. This is presumably due to soil, climatic, condition and altitude. In the following Table IV varieties are

...anged in order to show their respective places of ...ltivation in the scale of production.

TABLE IV

AREAS

...able	Bhanganj	Alubari	Sukia	Mani-Bhanganj	Semana
Red—Round	Great-Scot	Nainital	Nainital	Red—Round Nainital	Red—Round
White—Round	Nainital	Red—Round	Red—Round Great-Scot	Great-Scot White—Round	Nainital Great-Scot White—Round

Yield

There is hardly any comprehensive record showing the yield of various varieties of potatoes. It is therefore difficult to give an accurate idea of the yield of different production centres. Moreover, it may also be noted that the yield per acre varies

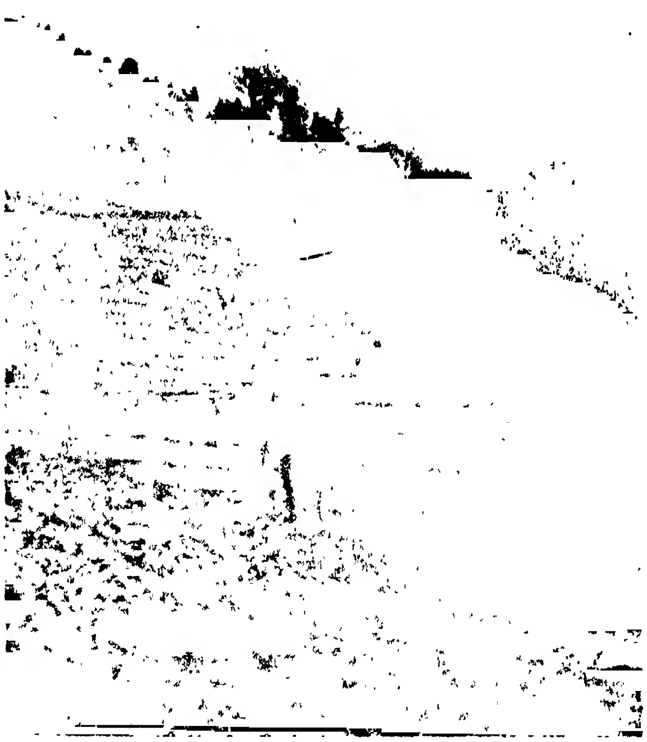


FIG. 1. Potato field in Darjeeling district. Note the rows of potato plants on the terrace.

from season to season, centre to centre and place to place in the same district. It depends on number of factors such as soil condition, time of planting, cultural operation, variety, irrigation facilities, and extent of damage done by diseases and pests.

In Table V an attempt is made to give an idea of the yield per acre of different varieties of potatoes cultivated at Darjeeling.

TABLE V

Variety	Yield per acre (in maunds)
Red—Round	60 to 70
White—Round	50 to 60
Nainital	90 to 100
Great-Scot	100 to 120

Diseases and Pests

The potato is generally victim to a wider array of diseases and suffers greater losses from these than any other agricultural crop. In India, they are infested with various types of diseases. It is impossible to find anywhere in India a potato field free from viruses. Leaf-roll, crinkle and mosaic are extremely common causing heavy losses amounting to often 50% or more of the yield. Apart from that, in the seed growing areas in the hills, diseases caused by fungi take a heavy toll,—late blight (caused by *Phytopthora infestans*) being a serious cause of loss to the growers. Along with this the caterpillar *viz.*, *Agrotis*, often destroys the potato plants and boars into the potato tubers underground causing serious damage to the crop.

FIG. 2. Potato plants being sprayed with "Perenox" to control the late blight disease. Note the Knapsack sprayers.

The control of these diseases and pests can hardly be neglected since on their control depends the quality of seeds. Of these diseases late blight occurs in the hills in epidemic proportion and can be controlled by spraying of crop with fungicide, *viz.*, 'perenox'. It may be mentioned that in Darjeeling where the amount of rainfall is much higher than that in the plains during the potato growing season, it was found necessary to use "Albolineum No. 2" along with 'perenox' to give the fungicide adhesive property.

Conclusion

It is apparent that Bengal with an acreage of over 2,00,000 under potatoes depends largely on supply of seed potatoes from other provinces. Moreover, the seed potatoes that are available are far from being free from diseases. So our immediate problem is not only to attempt to get disease free seeds but also to increase the acreages under cultivation of seed potatoes. To achieve the first objective it seems proper to take into consideration both short-term and long-term projects.

The objective of the short-term project will be to fill in the gap until such time when improved disease-free seed potatoes are ready for multiplication.

The programme of work for the short-term schemes will be mainly selection work from existing varieties and to multiply them. During this process of multiplication it is important that due care is taken to control viruses and other fungus diseases by modern methods, whereas in the long-term project the work should fall under two classes, *viz.*, (1) introduction of improved western varieties and (2) development of new varieties immune to diseases. In the work of introduction of western varieties, large scale importation of varieties should be undertaken followed by extensive trial of these varieties in various parts of the country. Varieties which will pass several years' severe trial test should eventually be multiplied for seed purpose. The varieties which are suitable to our climatic condition may also be profitably utilized for breeding purpose.

While developing the new varieties a far fetched breeding plan should be made to utilize the wild and native cultivated potatoes with a view to bring in desirable genes in commercial varieties, *viz.*, immune to diseases, higher protein content, better cooking quality, tolerance to tropical condition, etc. In carrying out comprehensive plan for breeding improved varieties due attention should be given to combine field immunity to viruses with immunity to other diseases. Coupled with these works there should be proper technical field staff organized to maintain the disease free stock and carrying out rigidly the certification of seed potatoes on the western model.

PROBLEM OF SOIL FERTILITY IN INDIA

A. KUMAR DUTT and M. L. DEWAN

Dynamic Nature of Soil

THE soil is a dynamic system. The climate does not change as rapidly as a soil does when the latter is brought under the plough. The opening up of virgin lands and the introduction of arable farming render the soil more dynamic. Weathering processes, erosion, and leaching become more active; and the accumulated reserve of soil fertility is gradually exhausted by the growing crops. The nutrients, taken up from the soil, are partly fixed up in the bodies of man and his domesticated animals, partly lost as human excreta or during the handling of the animal manures, or partly returned to the soil in the form of manures or stubble and straw. No matter what system of farming is adopted, either grain or livestock, soil fertility will gradually decline with corresponding decrease in crop yields unless some other sources of plant food are used to supplement the farm refuse or manures. Whatever amount of fertilizers is applied to replenish the annual loss of soil nutrients, the expected crop response will be less unless the culture of small grains or intertilled crops is rotated with the occasional growing of grasses, or better with a mixture of grasses and legumes. This practice is necessary in restoring the ideal soil tilth so characteristic of the virginity of forest or grass lands. Bradfield[1], in reviewing some of the works of Rothamstead, states, "There is little evidence to indicate, however, that a good physical condition of the soil can be maintained when planted continuously year after

[1] Bradfield, R., Soil conservation from the view-point of soil physics. *Jr. Amer. Soc. Agron.*, 29, 84092, 1937.

year to intertilled crops even when generously fertilized. The yields of wheat on the Rothamstead Experiment Station have declined and the physical structure deteriorated even when 25 tons of manure per acre per year were applied." Professor Williams, one of the leading agronomists in Russia, so aptly puts, "Soil structure is the key to soil fertility."

Depletion of the Soil.

The intensity of the loss of the different essential chemical elements of the soil, as brought about by the removal of growing crops, may be better understood by considering the distribution of these elements in the different part of the plant body, harvested wholly, or part thereof, during the various stages of growth.[2] Ordinarily, the percentages of nitrogen and mineral elements are greatest during the earlier stages of growth, while starch and celluloses accumulate as the crops mature. With the production of seed, nitrogen, phosphorus, magnesium and sulphur move to the growing reproductive organs, and the tendency for these elements is to concentrate in the seed coats. Most of the calcium and potassium, on the contrary, remains in the leaves and stalks. With the advancement of the maturity of the crop, a part of the nitrogen and a large part of its mineral elements, especially potassium, may be leached from it by rains to the soil. Although the chemical composition of crops is not always a indication of the state of soil fertility, yet it may give some idea as to the relative requirements of the different nutrients by the various crops. With certain limits, it may be stated in general that the nitrogen content of cereals, grasses and legumes is highest, followed by potassium, phosphorus, calcium, sulphur, etc. Legumes generally need potassium and sulphur in greater proportions than do cereals. Legume seeds, in comparison with the cereals, are high in nitrogen and ash. Likewise, legume hays contain higher percentages of nitrogen, calcium, magnesium, and phosphorus than do the non-legume hays, the cereal straws and corn stover.[2] It is evident that the growing of legume and its removal from the field tend to exhaust the mineral nutrients of the soil more rapidly than would be true with most of the non-legume crops.

It may be well to look into the intensity of depletion of soil nutrients by the livestock system of farming.[3] Calcium and phosphorus make up about 75 per cent of the total mineral matter of the body of the cattle, and 50 per cent of the minerals in milk. Approximately, 99 per cent of calcium and 80 per cent of the phosphorus of the body are present in the bones and teeth. The analysis of milk shows on the average high nitrogen and phosphorus content. The sale of wool involves primarily the losses of nitrogen and potassium. It may be said in general that the recovery of the nitrogen and minerals, fed to the cattle in crops, is, on the average, 74 per cent for nitrogen, 85 per cent for potash, and 62 per cent for phosphoric acid. As regards the distribution of these elements in the solid and liquid parts of the excreta, over 90 per cent of the potash and somewhat more than half of nitrogen are contained in the urine, while most of calcium and phosphorus are voided in the faeces.

The nutrients in food consumed by man may be considered a permanent loss to the soil under the present conditions. The elements released in excreta usually find their way either to the sewage drains, ponds, rivers, or seas. But as regards phosphorus, a major part of this element is fixed up in the making of bones and ultimately goes to the cemetry from which it is never returned to the soil. Of all the elements we are concerned with in plant and animal nutrition, phosphorus is the one to be deficient under any system of farming as there is a steady flow of this element from the soil which is seldom compensated in full, and not in our country.

The low state of soil fertility in our country was stressed by the report of the Royal Commission on Agriculture,[3a] 1928, as follows: 'Soils of Madras, Mysore, South East Bombay, Hyderabad, Central Provinces, Orissa, Chota Nagpur and south of Bengal are as a rule deficient in nitrogen, phosphoric acid and humus, but potash and lime are generally sufficient (p. 71). In the regur soils of India phosphoric acid, nitrogen and organic matter have been found to be generally deficient, (p. 72). . . Furthermore, the alluvial tracts of India which are agriculturally the most important have been found to be deficient in phosphoric acid, nitrogen and organic matter (p. 72)'.

This report also emphasized the loss to India of a valuable source of organic nitrogen and phosphorus as a result of the export of so large a proportion of its production of oil seeds, bones, and fish manures. The 5-year import of chemical fertilizers, as well as the export of the above-named materials together with the equivalent amount of plant food carried in them, are given in Table I.

As can be seen from the above table, 5,372,000 tons of oil-seeds, oil-cakes, bones, and fish manures —equivalent to about 1,334,000 tons of 20 per cent ammonium sulphate and 990,000 tons of 20 per cent

[2] Bear, F. E., Soils and Fertilizers, pp. 12-21. Willey & Sons, Inc., New York, 1942.

[3] Maynard, A., Animal Nutrition. McGraw Hill Book Co., Inc., New York, 1937.

[3a] *loc. cit.*, pp. 87-91.

superphosphate—were exported in 5 years against a negligible import of 5,000 tons[1] of fertilizers for the same period. This process of depletion has been going on for decades, intensified through indiscriminate export of such materials since the time of our losing control over our national economy. A number of leading Indians advocated to the Royal Commission the necessity of discontinuing the export of these organic manures by levying high tariff duties so that they could be utilized for fertilizing our soils, but without any success.

TABLE 1

5-YEAR EXPORT OF OIL-SEEDS, BONES, AND FISH MANURES AS COMPARED TO THE IMPORT OF ARTIFICIAL FERTILIZERS FOR THE SAME PERIOD.

Kind of products exported	Export for 5-years (1920-25) in '000 tons.[1]	Ave. Chemical Composition		Equiv. plant food carried in exported materials, in '000 tons.*		Import of chemical fertilizers in tons during 1920-25.[1]
		N	P_2O_5	Ammon. sulphate	Super-phosphate	
Cottonseed	686	6-9‡	2-3‡	257	86	5,000
Groundnut	1,240	3·98	0·75	247	47	...
Rape and mustard ...	1,181	4·0	1·5	236	89	...
Linseed	1,376	5·5	1·7	367	117	..
Sesamum . ..	119	3·5	1·5	21	9	...
Bones . ..	520	3-5‡	20-23‡	104	559	..
Fish manures	84†	9-14‡	9-25‡	48	71	...
Oil-cakes	166†	6·5	1·5	54	12	..
Total	5,372			1,334	990	5,000

* Ammonium sulphate and superphosphate contain 20 per cent N and P_2O_5 respectively.
† Real figures given were 38,870 and 165,600 tons (during 1921-26).
‡ Average figures were taken in circulation

Only recently has the influence of mineral salts upon health and nutrition received adequate recognition. Orr[4a] gives a review of the works done in India, with respect to the deficiency of minerals in pasture and their effects on nutrition. The extensive investigations[4] of Mccarrsion have indicated that the population in the regions of the Himalayas, and more or less throughout India, are prone to develop goitre due to the deficiency of iodine in the diet. The high mortality rate among cattle and the low milk yield have been attributed by several investigators to the deficiency of minerals, especially phosphorus in pasture herbage. The disease known as 'kumri'[4], which attacks horses by the development of paralytic symptoms and is especially frequent in the phosphorus-deficient areas of Bengal and Bihar, was reported by Davis. Ricket and tooth decay, now more common among the people of India, have been traced partly, and to a great extent, to the deficiency of calcium and phosphorus in the diet.

ORGANIC MANURES

The Indian farmers of today manure their crops inadequately and in most cases not at all. The dire poverty of our farmers forces them to convert the cow-dung into cakes and use them as fuel. Acharya estimates that the total amount of farmyard manure that may be available from the present source amounts to about 250-300 million tons per year, or about a ton per acre of land under cultivation. In spite of the marked variation of the farmyard manure, average farmyard manure, ready for field application, may be considered as containing 0·5 per cent of nitrogen, 0·25 per cent of P_2O_5, and 0·5 per cent of K_2O[6]. In other words, one ton of manure will contain 10 lbs. of total nitrogen, 5 lbs. of total P_2O_5, and 10 lbs. of total K_2O. But on the basis of readily available nutrients, one ton of average farmyard manure is considered to supply about 5 lbs. of nitrogen, 1 lb. of P_2O_5, and 5 lbs. of K_2O. Excluding the losses of potash and to a certain extent of phosphoric acid through erosion and leaching, and their slow availability and fractional fixation by

[4] Orr, J. B., Minerals in Pastures, pp. 113. H. K. Lewis & Co., Ltd., London, 1929.
[4a] *loc. cit.*, pp. 112-115, 120.

[5] Acharya, C. N., Composts and soil fertility. *Ind. Farming*, *I*, No. 2, 66, 1940.
[6] Lyons, T. L. and Buckman, H. O., The Nature and Properties of Soils, pp. 434. MacMillan Co., New York, 1943.

colloids and micro-organisms, the application of ton of manure per acre per year, as happens to the case in our country, will be just like a drop water in an ocean, and fall far short of meeting the requirements of the growing crops.

Great interest has recently been aroused by Howard[7] for making manure from straw and waste materials. They have usually a high C/N ratio and as such they need suitable amounts of some carriers of readily available nitrogen for rapid decomposition into humus. Besides, the process of decomposition is further accelerated by the presence of available phosphates and small amounts of lime. The agricultural value of compost will be discussed later. Howard, however, mentions that nitrogen appears in certain cases to be very slowly available but it is supposed that phosphorus, and especially potassium, are more readily available. Moreover, there are certain crops like cotton and tea which do not appear to respond to compost manuring.[8]

Sewage sludge should be classed with manure and compost as regards its fertilizing value. Only a small percentage of the total nitrogen present in sludge is immediately available to the plants, the potassium content is significantly low, and the phosphorus content, though usually lies between that of nitrogen and potash, is also of low availability. Under the present circumstances, the sewage treatment is exceedingly wasteful as most of the available plant nutrients, those that are water soluble, pass out of the plant. There is a general tendency among various people to consider manure, compost, or sewage sludge as complete fertilizers. This appears to be a gross-overstatement of their value. In fact, none of them can compete as a source of plant nutrients with commercial fertilizers, as may be seen from their composition given in the following table.

TABLE II

AVERAGE PERCENTAGES OF N, P_2O_5, AND K_2O IN MANURE, COMPOST, SEWAGE SLUDGE, AND ORDINARY COMMERCIAL FERTILIZERS.

	N	P_2O_5	K_2O
Manure	0·50	0·25	0·50
Compost[8]	2·19	1·20	0·58
Sludge :			
Raw	4·50	2·25	0·50
Digested	2·25	1·50	0·70
Activated ...	6·20	2·50	0·75
Commercial fertilizers :			
Sample I ...	15	10	10
Sample II ...	6	12	6
Sample III ...	10	10	10

[8] *loc. cit.*, pp. 220.

[7] Howard, A., An Agricultural Testament. Oxford Univ. Press, London, 1940.

[8] Acharya, C. N., Compost and soil fertility. *Ind. Farming*, *I*, No. 3, 121-25, 1940.

It is evident from the above table that the application of these organic manures will have to be made in the neighbourhood of 3-20 times as great to apply the same amount of available plant nutrients as one ton of complete fertilizer, assuming that the figures for organic manure stand for readily available nutrients ; but actually the application will be several times as great as 3-20 when the comparison is made between commercial fertilizers and organic manures as regards the supply of the same amount of available nitrogen, phosphoric acid and potash. These and other kinds of organic manures are treated primarily as nitrogen carriers and termed as organic ammoniates, calcium cyanamide and urea being excluded. They are low in phosphoric acid and potash. This is one of the reasons why it is customary among the occidental farmers to reinforce the organic manures with the addition of superphosphate, and sometimes with muriate of potash. They have, however, certain advantages over commercial fertilizers which will be discussed later in this article. Regarding the composition of the compost, as given in the table, it should be pointed out, however, some nitrogen carriers and superphosphates were added to make this particular compost.

COMMERCIAL FERTILIZERS

Generally,, in intensive farming, all three of the ordinary fertilizer elements, namely, nitrogen, phosphoric acid, and potash, are applied in considerably larger amounts than are required for optimum crop production ; and emphasis is put by the agronomists in the regular purchase and use of these constituents. In extensive farming, on the other hand, more dependence is placed upon the air for nitrogen (*i.e.*, the growing of legumes) and upon the soil for potash, with the result that the fertilizer employed is usually relatively high in its content of phosphoric acid. The recent report of the Fertilizer Technical Commission in India has recommended particularly the manufacture of nitrogen fertilizers in the form of ammonium sulphate for use in our agriculture. The report about the manufacture of this fertilizer constituent is elaborate and comprehensive and needs no further mention in this connection. The memorandum on the Development of Indian Agricultutre, issued by the Advisory Board of the Imperial Council of Agricultural Research, has also discussed to some extent the fertilizer problem of our soils, stressing the necessity of both nitrogen and phosphoric acid ; but no mention has been made of the potash problem of our soils. There are, however, certain points which we believe should be brought to the notice of our fellow agronomists and countrymen for judicious consideration.

The world's capacity for the production of nitrogen fertilizers by the different countries in

January, 1934, was about 5,082,300 tons, to which India, Austria, Australia, and Denmark contributed only 0·1 per cent of the total.* Before the world War II 62 per cent of the world's supply of nitrogen came directly from air, of which 90 per cent was produced by direct synthetic ammonia process, 9 per cent by cyanamide process, and 1 per cent by the Arc process. From the figures given by Bear and Collings on the world's consumption of the different forms of nitrogen fertilizers, it seems that of the total consumption 50 per cent is in the form of ammonium sulphate, 10 per cent as ammonium nitrate, 10 per cent as ammonium hydroxide, 12 per cent as calcium cyanamide, 8 per cent as calcium nitrate, 7 per cent as sodium nitrate, and 3 per cent as other by-products including organic ammoniates.

Under the present state of our soil fertility when most of the major plant nutrients are at a minimum, the use of nitrogen fertilizers alone is inadvisable; since the continual application of this element will impoverish the soil by removing large quantities of phosphoric acid and potash in the harvested crops. In using ammonium sulphate for the soils of the humid regions where the calcium and magnesium contents are low, we should remember that the continuous application of this form of nitrogen without lime causes toxicity to the plants by its acid effect. The residual effect of the inorganic nitrogen fertilizers is very little, about 65-95 per cent of the nitrogen applied is recoverable in the first crop. In the last few decades while the use of inorganic fertilizers has considerably increased, the popularity of organic ammoniates is rapidly waning. Principally, the high cost per unit of nitrogen and the slow availability of the major nutrient elements have prohibited the extensive use of organic fertilizers. Only about 60-75 per cent as much nitrogen is recoverable from the insoluble proteid organics as from soluble sources of inorganic nitrogen. Organic ammoniates, however, have certain advantages over the inorganic sources of nitrogen. The former are less subject to loss by leaching and have marked residual effect, depending on the rate of application; in addition, they contain traces of the rarer essential elements vital to plant growth. For these reasons in mixture of inorganic and organic nitrogen carriers is often recommended, especially in the humid climates. Nowadays, some of the proteid organics are being better utilized as feed for cattle, while others are finding their use as conditioners in fertilizer mixtures. One point should, however, be mentioned. The favourable effect of the organic manures on soil structure is often over-emphasized. Ordinary application has little effect, unless made to the extent of 8 tons or more per acre.

* Collings, G. H., Commercial Fertilizers, pp 72-73. Blackiston Co., Philadelphia, 1941.

There is a fundamental difference between the problem involved in the economy of nitrogen and in that of other nutrients. There are about 70,000,000 lbs. of elementary nitrogen in the air over every acre of land. The question now arises: how far can we go in meeting the nitrogen requirement of our soils by growing legumes? To this we should reply that the mere growing of legumes does not enrich the nitrogen level of the soil unless the entire crop is ploughed under as a green manure. The nitrogen fixed by the rhizobia is usually removed in the crops harvested. The practice of growing legumes, or better a mixture of grasses and legumes, for green manuring is indeed desirable from the viewpoint of maintaining permanent soil productivity. The practice does not seem to be very feasible under the present crop-producing capacity of our soils, when every acre of our available land is to be cultivated intensively for growing crops for human consumption. This can, however, be rendered possible by increasing the output of our present cultivable lands by the use of chemical fertilizers, as well as by bringing under plough the culturable waste and fallow lands which amount to about 170 million acres. Such measures will release the pressure on the lands, making room for the adoption of a more sound system of rotation.

Fertilizer Industry

The problem of utilizing bones for manuring purposes should receive special consideration in our country with a view to discontinuing their export and converting them into cheap and available form of phosphate for our soils. England was the first country to realize the importance of bones for the maintenance of soil fertility. Her own supply of bones was insufficient and the importation of large amounts annually from other countries, since the beginning of 1815, showed how apparently alert she was to the need for phosphorus than other European countries. Liebig, who devoted the first 20 years of his life to studies in the field of pure organic chemistry and later turned his attention to the mineral nutrition of plants, was greatly concerned with the food value of phosphoric acid. At his time bones were the principal source of making phosphoric acid. The great demand of England for bones from other countries brought a note of protest from Liebig against this practice. He stated:

'England is robbing all other countries of the condition of their fertility. Already in her eagerness for bones, she has turned up the battlefields of Leipzig, of Waterloo and of the Crimea; already from the catacombs of Sicily she has carried away the skeletons of many successive generations. Annually she removes from the shores of other countries

to her own the manurial equivalent of three million and a half of men, whom she takes from us the means of supporting, and squanders down her sewers to the sea. Like a vampire, she hangs around the neck of Europe—nay, of the entire world!—and sucks the heart blood from nations without a thought of justice toward them and without a shadow of lasting advantage to herself."[10]

The importance of the phosphate fertilizer industry cannot be underestimated in India where extensive deposits of natural phosphates have been reported to exist in the Trichinopoly district of Madras and in South Bihar, in a form in which they cannot be utilized unless manufactured as superphosphate. The actual world reserves of phosphatic rocks, as prepared by the Fourteenth International Geological Congress at Madrid, 1926, are about 17,371,250,750 tons (containing 2,360,410,628 tons of phosphoric acid), of which 8,128,000 tons occur in India. The world's consumption of phosphates in 1938 was nearly 11,957,919 metric tons to which India's share was only 23 tons. Europe and America consumed 81·18 per cent of the total; while that by the whole of Asia (excluding Asiatic Russia) was but 2·67 per cent.[11]

Due to the high fixing power of certain soils, say, laterites, for phosphates, and the low recovery of this nutrient in the first application which amounts to about 10-20 per cent, initial doses are to be made fairly large for satisfactory crop response. In view of our limited national sources of the superphosphate-making materials and of the uncertainties of the discovery of the fresh deposits, the problem facing the agronomists of our country today is: how can we increase most efficiently and economically the phosphorus content of our soils? The question is highly problematical and will remain unanswered until sufficient works have been done in our country with the different forms of phosphatic fertilizers. However, the authors would like to make a few suggestions in the light of the works done in other parts of the world, especially in the United States.

Rock phosphate is the cheapest source of phosphatic fertilizers, vast deposits of which have been found in North Africa, United States, and elsewhere. Our country can afford importing raw rock phosphate for supplying at an economic rate to our farmers. Doubt may be expressed as to the degree of availability of this material for maximum efficiency. Hopkins, the pioneer advocate of "Permanent Agriculture", has shown by his 25 years' experiments in United States that finely ground rock phosphate, under suitable conditions, is of high feeding value to the crop. Experiments continued since his death have demonstrated fairly well that deep-rooted crops, such as legumes, are particuarly efficient in obtaining phosphates from comparatively insoluble minerals; those in the grass family are next in efficiency, while the common vegetables are the least efficient. We should, however, remember that were these experiments done in the tropics the results might be somewhat different. Vageler,[12] one of the authorities on tropical soils, states that all attempts to use rich rock material for immediate conditioning or manuring of soils of the temperate regions has had very poor results; on the contrary, raw phosphate is often as effective as superphosphate in the tropics where cultivation operations and the high intensity of weathering affect the decomposition of soil materials in a much higher degree than in temperate climates.

As already stated, apart from meeting the phosphorus requirement of the growing crops, allowance is to be made for fixation by the soil and micro-organism. This will involve comparative large applications of phosphate fertilizers, to which raw rock phosphate can contribute much. In addition to rock phosphate, if we are to import other phosphate fertilizers, the highly concentrated forms of monocalcium phosphate (about 50 per cent available P_2O_5) and metaphosphate (62-63 per cent available P_2O_5) should be preferred because of low cost in transportation. Though they are not in general use, recent experiments have shown that they may be as effective, when used in equivalent amounts, as superphosphates. It is hard to discuss the phosphorus problem in detail in this article, but we would rather like to express ourselves in the words of Pierre,[13] "Phosphorus has sometimes been called the master key to agriculture. Its importance in general farming is indicated by the fact that low crop production is due more often to a lack of phosphorus than to the lack of any other element." Thus, we must see that there is a constant and substantial flow of phosphorus into the soil as we remove this element in the harvested crops.

From the report of the Royal Commission on Agriculture, it seems that our cultivated lands are supplied with sufficient amounts of potash. This statement is rather misleading. It has been shown in United States that most soils which have been farmed for a quarter of a century or more produce somewhat larger yields if some soluble potassium salt is added to them. We admit that the depletion

[10] Aikman, C. M., Manures and the Principles of Manuring, pp. 360. Blackwood, Edinburgh, 1902.

[11] Gray, A. N., Phosphates and Superphosphates, pp. 80-81, 85-86. International Superphosphate Manufacturers' Assen., Great Britain, 1944.

[12] Vageler, P., Tropical Soils, pp. 18. MacMillan & Co., Ltd., London, 1933.

[13] Pierre, W. H., Phosphorus deficiency and soil fertility, pp. 377. Soils and Men. Year Book of Agriculture, U.S.D.A., 1938.

of potassium is less intensive than that of nitrogen and phosphorus, nevertheless, potassium is likely to be deficient in sandy soils and the highly leached soils of the humid parts of our country. Moreover, most crops in tropics require large amounts of potash and this element may turn up as a limiting factor in maximum crop production as soon as our present fertility level will be stepped up by the use of nitrogen and phosphate fertilizers.

Natural potash deposits of workable size have not yet been explored in India, except the crude forms of nitre and saltpetre which occur as an efflorescence in the surface soils of the arid regions of our country. India has, however, the largest deposits of mica in the world and the possibilities of utilizing it as a plant food in a finely divided state have so far remained untapped in our country. The experiments, using potassium-bearing minerals as a source of nutrient, are rather meagre. According to Vageler[11] slow weathering in temperate regions makes obsolete the use of mica as a plant nutrient; on the contrary, in soils of hot tropical regions fresh biotite can hardly be recognized even in comparatively young soils. This problem of mica ought to be more fully exploited in our country before any definite conclusions can be drawn. Incidentally, about 40-65 per cent of the added potassium is recoverable in the first crop, thereby indicating residual effects for the succeeding crops. Mention should, however, be made of some experiments which obtained increased yields for certain crops by partly substituting sodium for potassium. Thus sodium, because of its cheap and abundant source, may act as conserving soil potassium in the humid regions, without any detrimental effects on soil structure.

The agronomic importance of calcium, magnesium and sulphur, as well as of the essential minor elements like iron, manganese, boron, copper, zinc, and possibly molybdenum, should not be ignored. Experiments with chemical fertilizers have stressed the fact that it is necessary to reinforce the fertilizer mixture with minute quantities of the minor elements; calcium, magnesium, and sulphur being present as constituents of the mixture. Besides, calcium is used for liming or reclaiming soils, although to a limited extent by our farmers. It is not possible for review here the works done with minor elements in different parts of the world, yet it may be assumed with a fair degree of accuracy that with the use of chemical fertilizers in India the deficiency symptoms due to the insufficient amounts of minor elements now contained in our soils, may be gradually manifested with increased crop production. One can see the truth of this statement by looking into United States, Australia, and other countries, where the soils have been cultivated only for a few centuries but where deficiency symptoms due to minor elements have already been reported.

The 'Phlogistonists' in agronomy, advocating the use of compost as an overall soil tonic, must face the facts from extensive experiments done with chemical fertilizers which have not only shown increased yields of crops but, which, aided by good soil management and farming practices, are also keeping the soils in a very high state of productivity, for maintaining those high yields. Modern agriculture recommends the return to the soil of all kinds of wastes and refuse, whether from cities, towns, villages or farms, but at the same time it realizes the shortcoming of this return in replenshing the nutrients depleted annually by harvested crops, leaching, erosion, etc. The organic manures, like cow-dung, compost, and sewage sludge, may, however, serve as supplements to meet partially the nutrient requirements of soils.

In view of the terrific calamities of the last Bengal famine of 1943 and in the face of another more devasting famine looming over our country, at the present moment the problem "Why Must We Starve" seems more pertinent now than ever before. For the solution of this problem we must turn our attention to mother earth whose age old starvation we have so far neglected. Only when we shall care for feeding her with manures and fertilizers, will she begin raising again plenty of food for our starving and hungry people.*

[11] Vageler, P., Tropical Soils, pp 37.

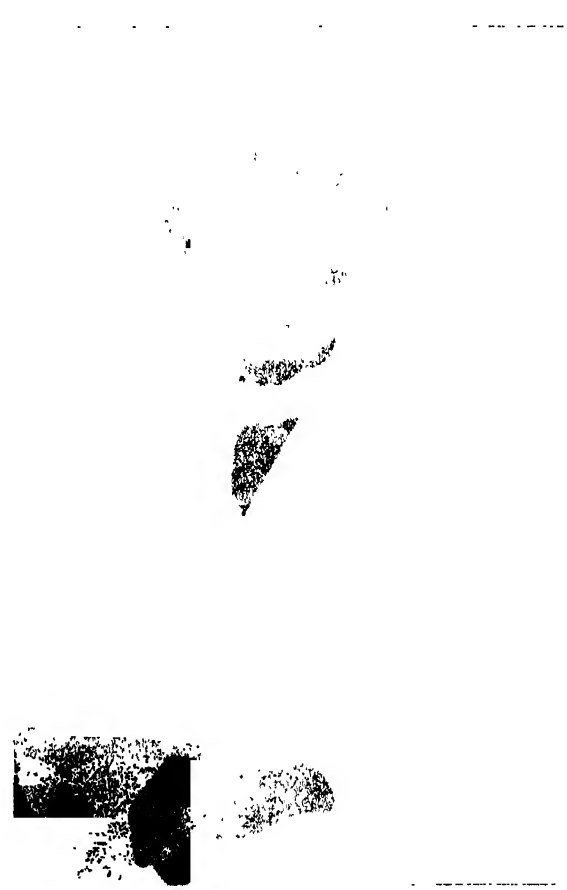
* The authors are indebted to Dr R. Bradfield, Prof. of Soil Fertility, and Head of the Dept. of Soils and Agronomy Cornell University, for his valuable advice and suggestions.

OBITUARIES :

MAX PLANCK (1858-1947)

WE regret to announce the death of Professor Max Planck during the first week of October in Goltingen, at the advanced age of eighty-nine. His name will go down to posterity as the formulator of the quantum hypothesis. On the occasion of the celebration of the fiftieth anniversary of Planck's doctorate in June 1929, Bohr wrote 'In the history of science there are few events which, in the brief space of a generation, have had such extraordinary consequences as Planck's discovery of the elementary quantum of action. Not only does this discovery to an even increasing degree, form the background for the ordering of our experience concerning atomic phenomena, the knowledge of which has been so amazingly extended during the last thirty years, but at the same time it has brought about a complete revision of the foundations underlying our description of natural phenomena. We are dealing here with an unbroken development of points of view and of conceptual aids which, beginning with the work of Planck on black body radiation, has reached a temporary climax, in recent years, in the formation of a symbolic quantum mechanics. The theory may be regarded as a natural generalization of the classical mechanics with which in beauty and self-consistency it may well be compared'. It is interesting to note that Planck's first formulation of the quantum hypothesis in 1900, preceded by five years, the other revolutionary change in theoretical physics introduced by Einstein in 1905, by his relativity postulate. These two theories have, between them, necessitated a searching criticism of concepts which, taken over from our world of every day experience, were applied to the theoretical interpretation of experiments of increasing degree of accuracy.

Max Planck was born at Kiel, Germany, on April 23, 1858. His father was a noted professor of Constitutional Law, first at Kiel and then at Göttingen. He is known as the co-author of the Prussian Civil Code. It is said that Max Planck inherited from his father the juridical faculty of sifting experimental evidence, of disentangling the significant from the meaningless. From his early family associations also, he derived his attitude towards physical science as a branch of human culture, forming an integral part with other branches of human learning, and exercising its influence on human destiny, not only in a material way, but even more deeply in a spiritual way. During the early period of the World War I, he used to preface the first lecture in each Semester with the remark: 'Our thoughts are with our brothers and sons who are risking their lives for the defence of German culture; when they return they will ask of us what have we done to advance this culture. Let us not fail in our duty'. When the revolution broke out in Berlin in November 1918, which brought the war to an end, Planck referred to it with the remark 'we are passing through a very critical period in our national life. At another similar period of our history (referring to Napoleon's occupation of Prussia), it was German



PROF. MAX PLANCK

culture which rallied the nation'. Planck remained a liberal all through the critical period of German history, commencing from the first War to that of Nazi domination. It was he who, during his presidentship of the Kaiser Wilhelm Institute, organized, in spite of official Nazi displeasure, a memorial service to Fritz Haber. The latter by his large scale production of artificial fertilizers enabled Germany, in spite of blockade, to carry on the war for over four years. Haber was deprived of his post in the Kaiser Wilhelm Institute and banished from Germany on account of his Jewish origin. Planck

lost a son during the first war and previously he had lost two daughters.

Planck entered the Munich University when seventeen years of age; after three years of study, he migrated to Berlin to study under Helmholtz, Kirchhoff and Weierstrass. Kirchhoff aroused his interest in thermodynamics, specially in the second law. He obtained his doctorate with *Summa cum Laude* from Munich in 1879, with a dissertation on '*The second fundamental law of the mechanical theory of heat.*' In 1887 he was awarded the Beneke Prize by the Göttingen University for his essay on '*The Principle of Conservation of Energy*'. After serving as Privat Dozent in Munich, he became Professor in Kiel in 1885, and later he went over to Berlin in 1889, as extraordinary professor; in 1892 he succeeded Kirchhoff as ordinary professor. In 1912, he became the permanent secretary to the Science section of the Prussian Academy. It was through his efforts, that in 1914 Einstein came to Berlin as a Professor of the Prussian Academy. In 1918 he was awarded the Nobel Prize in Physics. In 1927 he retired as Professor Emeritus, being succeeded by Schrödinger. In 1930, on the death of Adolf Harnack, he was elected President of the Kaiser Wilhelm Institute. Not much is known of his subsequent activities; he however attended the Newton Tercentenary celebration held in 1946 in London.

I attended Planck's lectures on theoretical physics during my study in Berlin, 1914-1918. It extended over a period of three years, and was divided into Mechanics, Electromagnetism and Optics, and Thermodynamics. The first two subjects, which are made up only of reversible processes, were developed deductively from Newton's laws and from Maxwell's electromagnetic equations. His last course of lectures was a survey of the System of Physics, which he divided into reversible processes, obeying dynamical laws, and irreversible ones obeying statistical laws. Equations representing the former were all deducible from Hamilton's Principle, when suitable values were put in the terms representing Kinetic and Potential energies. The irreversible processes, susceptible only of statistical treatment, were considered especially in connection with the interaction between matter and radiation. The change in the structure of the phase space necessary to pass over from classical to quantum statistics, formed the culminating portion of this course of lecture. Teaching of Physics as I had found in Cambridge, after attending lectures of Larmor, Thomson, C. T. R. Wilson and others, consisted of lectures on selected topics in certain branches of the subject, each of which extended over a term of eight weeks. There was no continuity of treatment in the lectures delivered in successive terms, and some of them were not well prepared and were badly delivered. This was the traditional way of teaching in the older Universities of England forty years ago; it produced isolated men of genius, but not research schools. It was a revelation to me to realize, after attending Planck's lectures, what a System of Physics meant in which the whole subject was developed from a unitary stand point and with the minimum of assumptions. Planck delivered four lectures each week, and in addition one day was set apart for the solving of problems. The latter were selected to familarize the students in the application of physical principles to problems, and not for the purpose of exercising their mathematical ingenuity.

Planck's principal contributions were in Thermodynamics, and in the theory of Heat Radiation. In thermodynamics his principal contributions were in the theory of dilute solutions, while in Munich he even undertook some experimental work to verify some assumptions introduced in his theory. His text book on Thermodynamics has become a classic. In the later editions Nernst's Heat Theorem is deduced from quantum considerations. His chief contribution, however lie in his investigations on Heat Radiation. A series of papers, published between 1895 and 1900, led to the formulation of his famous black body radiation formula in 1900, which has so far triumphantly stood all experimental tests. His 'Vorlesungen uber die Theorie der Warmestrahlung', was first published in 1906 and had, upto 1921, gone through four editions, in each of which he tried to improve the theoretical treatment of the subject. His treatment of this constantly developing subject, has not the classic form which makes the study of his Thermodynamics so satisfying. The main contributions to both the theoretical and experimental development of the subject of thermal radiation, has been due to German scientists. Kirchhoff first introduced the concept of cavity or black body radiation, which is found inside an uniformly heated enclosure in thermal equilibrium. Such radiation should have properties which are independent of the specific nature of the material bodies enclosing it or imbedded in it. The spectral distributions of energy in such radiation should be a function of temperature T and frequency ν or wavelength λ only, $K_\nu = f(T, \nu)$ and $K = \int_0^\infty f(T, \nu)\, d\nu = F(T)$. From experimental and theoretical investigations respectively, Stefan and Boltzmann established the relation that the total energy of radiation $K = \sigma T^4$ (1). Wien showed that if a cavity radiation is enclosed within an enclosure made up of collapsible perfect reflectors, then on reversibly compressing or expanding

enclosure, it does not alter the black body character of the enclosed radiation. His thermodynamical investigations led to his discovery of the general form of the spectral distribution of energy formula $K_\nu = \frac{\nu^3}{c^3} f\left(\frac{\nu}{T}\right)$. A deduction from this equation is that the frequency at which the radiation possesses the maximum energy at any temperature ν_{max} = const. T, which can also be written in the form λ_{max}. T = b (2). The next problem was to deduce the form of the unknown function $f\left(\frac{\nu}{T}\right)$. Wien, from some reasoning based upon an application of Maxwell's Distribution Law, which is not free from objection, found $f\left(\frac{\nu}{T}\right) = \alpha . e^{-\frac{\beta\nu}{T}}$ which leads to the radiation formula $K_\nu = \alpha \frac{\nu^3}{c^2} e^{-\frac{\beta\nu}{T}}$ (3). These three formulas were tested by means of large scale accurately carried out investigations, chiefly by Lummer, Pringsheim and Kurlbaum in Berlin, which were commenced in 1895. While the first two relations could accurately be verified, Wien's Spectral Distribution Law was found to be correct only for large values of $\frac{\nu}{T}$ or small values of λ T. Further extended investigations upto temperatures as low as 150° A and λ upto 18μ, showed that the deviation from the theoretical formula became considerable for $\lambda T > 3000$.

At this stage Planck started his investigations. He considered the condition of equilibrium between a system of material bodies, considered to be made up of electric oscillators of frequency ν, and at temperature T, and the surrounding radiation. It was found that the following relation existed between K_ν, the intensity of black body radiation of frequency ν, and the average energy $\bar{u}$ of the system of oscillators, $K_\nu = \frac{\nu^2}{c^2} \bar{u}$. Planck's first attempt to deduce an expression for $\bar{u}$, lead to Wien's spectral distribution formula, which did not agree with the experimental results. Being convinced of the general validity of Maxwell's equations, Planck considered that alteration, if any, to be introduced for obtaining a radiation formula in better agreement with experimental results should lie in the alteration of the statistical laws of thermodynamics from which the value of $\bar{u}$ is deduced. He then first introduced the radical hypothesis, that the oscillators could have only a discrete set of energy values which are all multiples of a unit ϵ. This leads to the first form of Planck's quantum hypothesis, *viz.*, absorption and emission of energy by a system of oscillators are in quanta, which are multiples of a unit ϵ, whose value was not specified. By suitable application of Boltzmanns theorem, connecting the entropy S and the probability W of a given distribution of a set of discrete energy values all multiples of a unit ϵ, in a system of N oscillators, Planck obtained the following value for $\bar{u} = \frac{\epsilon}{e^{\frac{\epsilon}{kT}} - 1}$ from which he obtained the now well known radiation formula $K_\nu = \frac{\nu^2}{c^2} \cdot \frac{\epsilon}{e^{\frac{\epsilon}{kT}} - 1}$, a comparison with Wien's general formula $K_\nu = \frac{\nu^3}{c^2} f\left(\frac{\nu}{T}\right)$ lead to the conclusion that $\epsilon = h\nu$. This represents Planck's famous quantum condition, *viz.*, oscillators of frequency ν absorb and emit radiation in multiples of $h\nu$. Planck's radiation formula has been found accurately to represent the spectral distribution of energy in black body radiation over a wide range of temperature and wave-length, and has now been raised to the status of a law of Nature.

Planck's quantum hypothesis was of a revolutionary character, representing a break with the principle of equipartition of energy; the latter represents the limiting case of $h \to 0$, and leads to the relation $\bar{u} = kT$ for oscillators, independent of their natural frequencies. The general body of physicists did not know what to make of it. One of the first successes of the theory was, that it enabled an independent determination of the value of the charge of an electron, which Planck calculated in 1900 and found to be equal to 4·69 e.s.u.; it compares very favourably with the latest experimental value of 4·8025. This agreement had convinced Rutherford, in 1908, of the essential correctness of Planck's theory. Already in 1905 Einstein had made the assumption, that the energy quantum not only played a role during the exchange of energy between oscillators and radiation, but the radiation retained its quantum character during its propagation in space. This light quantum hypothesis enabled Einstein to deduce his famous photoelectric equation, which was verified later by Millikan and others. Since then there has been a progressively increasing application of the quantum hypothesis to different kinds of atomic processes.

Planck, a classicist by temperament, however did not feel satisfied with the radical nature of the quantum assumption, which represented a total break with the continuity hypothesis of classical physics. In 1912, he proposed a modification of his quantum hypothesis, in which it is assumed that both the electromagnetic radiation in space and its

absorption by oscillators followed the laws of electrodynamics, while the emission of radiation by the oscillators represented a discontinuous process, and only took place when the oscillator energy reaches a value which is a multiple of a quantum $h\nu$. In this connection Planck for the first time, formulated the idea, that the occurrence of energy quantum is a secondary consequence of a more fundamental and general law which can be expressed as follows. The state of a linear oscillator at any instant can be represented by a point on the phase plane pq where, q is the positional and p the momentum coordinate. The representative point of an oscillator with constant energy will lie on an ellipse. The phase space can be divided into equal areas of value h bounded by a system of concentric and coaxial ellipses, each of which encloses an area $\int pdq = nh$. Along the nth phase element the oscillator energy has a value $nh\nu$. According to Planck's first hypothesis, the oscillators can only lie on the curves for which the quantum of action $\int pdq$ has the discrete values nh. While according to the second hypothesis, the oscillators are uniformly distributed over each phase element, but the distribution function varies discontinuously from one element to the next and further emission only takes place in discrete units, when the oscillator reaches one of the boundary curves. The quantity $H = \int pdq$ which represents the action integral, occupies a central position in classical physics and is assumed to vary continuously for a material system. Planck introduced a radical departure when he postulated the existence of a quantum of action in all mechanical systems with periodic orbits. A consequence of this is that Gibbs phase space is given a definite structure and is made to consist of elements of volume h^f, when f is the degree of freedom of the mechanical system.

The second formulation of quantum hypothesis by Planck could not for long bridge over the difficulty of combining the wave and particle representation of light quantum. In 1925 Louis de Broglie had introduced the idea of a group of waves being associated with a material particle. The inconsistency between classical and quantum assumptions, underlying the quantum theory developed by Bohr and Sommerfeld, led Heisenberg in 1925 to formulate his new Quantum Mechanics, which was based upon a corpuscular analogy, and in the following year Schrodinger developed his Wave Mechanics, which was inspired by de Broglie's hypothesis. Both the theories, which were found to lead to equivalent quantitative results furnished exact mathematical laws which quantitatively accounted for the observed experimental data.

The discovery by Davisson and Germer and by G. P. Thomson, that electrons possessed wave like properties, from which it followed that both matter and radiation possessed a remarkable duality of character, as they some times exhibited the properties of waves and sometimes of particles. Both the pictures are however incomplete. This has led to a critique by Bohr and Heisenberg of the concepts underlying a consistent description of nature according to classical physics. Two of the important ones are (*i*) that natural phenomena obey exact laws, the principle of causalty. This is based upon the implicit assumption that it is possible to observe phenomena without influencing them; (*ii*) that all phenomena must be explained as relations existing in space and time. An earlier critique of the concepts of 'measuring rod' and 'clock' was undertaken in the relativity theory by Einstein. But in this theory the traditional requirement of science is still fulfilled, as it permits a division of the world into object and subject and hence a clear cut formulation of the law of causalty. In the present instance the concepts of space time coincidence and of observation require revision, and in particular the interaction between observer and object. Heisenberg has, by using as illustration some ideal experiments, shown how it is impossible to obtain an exact determination of the simultaneous values of canonically conjugate variables like space (q) and momentum (p) coordinates. There is a limit to the accuracy with which they can be known, and this can be formulated as a law of nature in the form of the so called 'Uncertainty Principle' $\Delta p . \Delta q \geq h$. The uncertainty relation gives us a measure of freedom from limitations of classical concepts, including that of causalty, which are necessary for a consistent description of atomic processes. Bohr has pointed out, that by replacing the action principle, which occupies a central position in classical description of Nature, by the quantum of action h, Planck had intituitively shown the way to a new description of Nature.

It follows from the above that the causal description of phenomena in terms of time and space has to be replaced in the Quantum Theory by one or other of the following alternative modes of description. They are: (*i*) phenomena are described in time and space but subject to uncertainty relation or (*ii*) causal relationship is expressed by mathematical *i.e.*, statisteal laws, but physical description of phenomena in space and time is impossible. The limitation imposed on the application of principle of causalty in atomic phenomena, has again revived discussion, which has persisted from earliest time, on the relation between the law of causalty and freedom of human will. Some people have drawn with Eddingtion the conclusion that "the activities of consciousness do not violate the laws of physics, since in the present indeterministic scheme there is freedom to operate within them". Eddington states further "These revolutions of scientific thoughts are

clearing up the contradictions between life and theoretical knowledge. The latest phase with its release from determinism, is one of the greatest steps in the reconciliation. I would even say that in the present indeterministic theory of physical universe we have reached something which a reasonable man might also believe." There has been a large volume of discussion on whether (*i*) the principle of causality is an empirical law capable of experimental proof or (*ii*) is it conceivable only as a form of theoretical system? According to Planck, 'Science having assumed the existence of an independent world, concomitantly also assumes the principle of causalty independent of sense perception . . . . Science finds itself here exactly on the same footing which Kant took as his starting point of the theory of knowledge . . . the causal concept is accepted at the outset as belonging to those categories without which no knowledge is possible.' Einstein, who is also a believer in the principle of a causalty, concedes that modern physicists are mainly of the opinion 'that it is inadmissible to build up any sort of theory on that can not in principle, be tested'.

Distinguishing between dynamical and statistical causalty, Planck said, 'In principle it does not matter which of the standpoint is chosen first . . . My own belief is that the assumption of a strict dynamic causalty is to be preferred, simply because the idea of a dynamically governed universe is of wider range and deeper application than the mere statistical idea ; because in statistical physics there are only such laws as refer to groups of events. The single elements are introduced and recognized expressly ; but the question of their law governed sequence is declared senseless on *a priori* grounds.'

The question of the reality of the external world behind the phenomenal one was the subject of a famous controversy between Mach and Planck. There is a school of philosophers and physicists, whom Planck designates as Positivists, according to whom the subject matter of all scientific construction are based upon data supplied by our sense perception. Construction based upon the latter form our phenomenal world ; it is the business of physical science solely and exclusively, in the most simple and accurate way, to describe the order observed in studying natural phenomena. There is no means of attaching to them an ulterior significance, *viz.*, the existence of a real world derivable from such sensory measurements. Out of two different ways of making a construction based on sensory reactions to some outer phenomena, the one is to be preferred which subsumes a larger number of sense data, but there is no claim in it of being a more accurate picture of an external reality. For example, according to Mach, the Ptolemaic and the Copernician description of the motion of the planetary and stellar world as viewed from the earth, have the same degree of validity, but the Copernician theory is more widely accepted because it is a simpler way of formulating a synthesis of sensory observations and it does not give rise to so many difficulties about astronomical laws, as would arise from a Ptolemaic description.

According to Planck there are two theorems on which the whole structure of physical science turns. These are (*i*) there is an external world of reality which exists independently of our act of knowing and (*ii*) the real world is not directly knowable ; it is however the aim of the physicist to understand this world. For this purpose he makes what are known as physical measurements, but these give no direct information about the external reality. They are only registers or representation of physical phenomena, and require to be interpreted. The physicist makes the assumption that the physical universe is governed by some system of laws. He then proceeds to construct a system of concepts and theorems, and this synthesis is called the scientific picture of the physical universe. "That we do not construct the external world to suit our own ends in the pursuit of science, but vice versa, the external world forces itself on our recognition with its own elemental power is a point which ought to be categorically stated again and again in these positivist times".

Einstein in an address delivered on the occasion of celebration of the 60th birth day of Planck on April 23, 1917, interprets the latter's theoretical out look as follows 'In every important advance, the scientist finds that the fundamental laws are simplified more and more (in the theoretical sense) as experimental research advances. And this cannot be traced back to the working of his own mind, but to a quality which is inherent in the world of perception. Leibniz well expressed the quality by calling it 'pre-established harmony'. I think that was the basis of the controversy waged a few years ago between Mach and Planck. The latter probably felt that Mach did not fully appreciate the physicists longing for pre-established harmony".

The age of Planck and Einstein has been very much interested in discussions on the fundamental concepts of theoretical Physics. Heisenberg points out their importance in the following words, "To mold our thoughts and language, to agree with observed facts of atomic physics is a very difficult task, as it was in the case of the theory of relativity. In the latter case it proved advantageous to return to the older philosophical discussions, of the problems of space and time. In the same way it is now profitable to review the fundamental discussions, so important for epistemology, of the difficulty of separating the subjective and objective aspects of the world. Many of the abstractions, that are

characteristic of modern theoretical physics, are to be found discussed in the philosophy of past centuries. At that time, these abstractions would be disregarded as mere mental exercises by those scientists whose only concern was with reality, but we are today compelled by the refinements of experimental art to consider them seriously."

D. M. Bose.

GEORGE MATTHAI, (1887-1947)

Prof G. Matthai, formerly of the Indian Educational Service and Emeritus Professor of Zoology in the Punjab University, died suddenly at Cambridge on 25th June, 1947.

George Matthai hailed from a cultured Syrian Christian family in Travancore. He was born on the 14th November, 1887, and was the third son of the late Mr Thomas Matthai, a teacher in the C. M. S., Collegiate School at Kottayam, Travancore. His eldest brother, the late Rao Sahib Cherian Matthai, was the Director of Public Instruction, Cochin State, and his other brother is Hon'ble Dr John Matthai, the present Minister for Railways and Transport in the Government of the Indian Union.

Matthai had his early education at the Zamorin's College, Calicut and later at the Christian College, Madras, where he took his B.A., and M.A., degrees. He served on the staff of the Christian College as lecturer in Zoology for about a year and then proceeded to Cambridge in 1911 to take up a career of research. He joined the Emmanuel College under Prof Stanley Gardiner and soon earned a reputation for his researches on the morphology and classification of the 'Madreporarian Corals'. As a recognition of the importance of his researches at Cambridge, Matthai was awarded the Mackinon Research Studentship of the Royal Society.

Matthai was one of the pioneer Indian zoologists of international reputation and a great authority on corals. He published several valuable monographs on corals, notable among them are his monographs on the 'Astraeidae' published in the *Transactions of the Linnean Society of London* in 1914, the *British Museum Catalogue*, 1928, and a revision of the 'Madreporarian Corals' in the *Memoirs of the Indian Museum*, 1924. His important work on the histology and modes of budding in corals, as determining the forms of the colonies, appeared in the *Philosophical Transactions of the Royal Society*, 1926. When the writer met Prof. Matthai in Cambridge in June-July 1946, he was actively engaged in completing a work on 'Colonial Fungidae', which had been interrupted by the War. He had hoped to complete this by the end of October 1947. After that he had planned to write a 'Monograph on Corals' in the course of three years and in 1950 he expected to begin the work on Corals for the "Fauna of British India" series, promising the first volume in two years' time. His plan was to contribute 2 or 3 volumes to the series. Matthai had examined all the existing Type Collections of Corals in Europe and America for his taxonomic work and he undertook several cruises along the coast of Florida, in the West Indies and in the Indian Ocean in search of his material.

In 1919, he succeeded the late Lieut.-Col. J. Stephenson as Professor of Zoology at the Government College, Lahore, where he soon established himself as a very able teacher. During his tenure of office as Dean of the University Studies, Matthai did much to stimulate Zoological Research in the Punjab. He was a man of great learning, gifted with fertile imagination, and laboured continually to provide a sound and fundamental training in all branches of Zoology. He was ever ready to give counsel to those who sought his advice, and was deeply interested in the welfare of his students.

As a recognition of his contribution towards the advancement of Science, Matthai was awarded the degree of D.Sc., by the University of Cambridge in 1920. He presided over the Section of Zoology of the Indian Science Congress held at Lucknow in 1923, and the Jubilee Session held at Calcutta in 1938. He dealt with researches in Oceanography and the Marine Fauna in both the Presidential Addresses. He was one of the Foundation Fellows of the National Institute of Sciences of India, a Fellow of the National Academy of Sciences, of the Linnean Society of London and the Royal Society of Edinburgh.

He retired from service in 1943, but continued his research activities. He acted as Director of the Zoological Laboratory at the University of Madras for some time in 1946.

In 1925, while on leave in England, he married Mary Chandy, the second daughter of the late Mr C. Chandy of the Mysore Civil Service and later a Vice-Chancellor of the University of Mysore. Unfortunately in 1931 his wife died after the birth of a son, the only child, who survives him.

In the sudden death of Professor Matthai, the Science of Zoology has lost a great devotee, and the zoologists in India deeply mourn his loss.

S. L. Hora.

Notes and News

COAL IN FREE INDIA

The 23rd Annual General Meeting of the Geological, Mining and Metallurgical Society of India was held on October 31 last at Calcutta with the Hon'ble Sri N. V. Gadgil, Minister, Works, Mines and Power as the Chief Guest on the occasion. Sri Shusil Ch. Ghosh presided.

In his presidential address, Sri Ghosh sounded a note of warning about the future of coal in India unless immediate steps were taken to ensure conservation. For the proper development and growth of this industry, a well-defined National Mineral Policy is badly needed and the ownership of mines and minerals be vested solely in the Central Government under an exclusive Ministry of Mines and Minerals.

Continuing Sri Ghosh referred to the fact that apart from the control of the various provincial governments, this basic industry is now under six different Ministries of the Central Government. In matters of mineral policy it is guided by the Ministry of Works, Mines and Power; the allocation and distribution of coal and fixation of coal prices are done by the Ministry of Industries and Supply; wagon supply in the coalfields is in the hands of the Ministry of Transport; matters affecting the labour are dealt with by the Ministry of Labour; for supply of foodgrains to the mining labour it has to look to the Ministry of Food: and lastly, in the matter of taxation it is under the Ministry of Finance. The industry thus badly suffers for want of proper co-ordination between so many Government Departments.

For planning a rational coal utilization policy, Sri Ghosh emphasized for an extensive fuel research. There must be some sound basis for exploiting India's coal resources, major portion of which is admittedly of inferior grade. The proposed grant for fuel research, was quite inadequate and he appealed to the Government to allot more funds for the purpose.

Concluding Sri Ghosh said "the coal industry is in the melting pot. The uncertainty of its future position in the economic set up of this country; indecision and hesitating policy of the Government with regard to many of its vital questions; dual control by the Central and Provincial Governments; continuance of war-time control without any modification; inequitable and inadequate wagon supply; strikes and disturbances all over the country resulting in much less coal consumption; deteriorating railway transport system; a perplexing labour policy; and the heavy burden of Provincial taxaiton imposed especially on the coal industry are the contributing factors in worsening the coal position. Not a day should therefore be lost to remedying matters".

Referring to the question of National Mineral Policy, Sri Gadgil said it has already been accepted in principle by the Government. There must be a complete agreement between the people and the Government on this vital issue, and this Society will have an important part to play in shaping the public opinion on this subject. Government have already accepted the recommendations of the Mineral Policy Conference held at Delhi in January last. The objectives underlying this policy are: attainment of mineral and metal self-sufficiency as far as possible; central control over the exploitation of minerals of strategic and national importance; acquisition by the State of mineral rights in land; regulation of the international trade in minerals of key importance; encouragement of local manufactures, especially of non-ferrous metals and products now imported from abroad, *e.g.*, aluminium, ferro-alloys, alloy-sheet and -metals, heavy chemicals, mica goods, titanium plants, etc.; revision of existing mineral concession rules, for securing uniformity in conditions of mineral exploitation; and encouraging the development of mineral-bearing areas.

Unhappily the gap between enunciation and implementation of this policy is a wide one. For bridging the gap Sri Gadgil, emphasized for an instrument of policy and with this end in view a technical organization in the centre, on the lines of the existing organizations for development of electricity and waterways have to be established; secondly, the provinces have to be guided and assisted for a similar technical organization for exploitation and development of key minerals and local resources; and lastly, to carry out mineral and metallurgical research on an all-India basis, on the production, processing and marketing of our minerals of national importance.

Concluding Sri Gadgil said "when we set up our own Bureau of Mines and the net-work of Provincial Bureaus, we shall have well and truly laid the foundations of a sound all-India organization for the development of our mineral resources".

The following were duly elected office-bearers of the Society for the year 1947-48: *President*: Dr S. K. Ray; *Joint-Secretaries*: Profs. N. N. Chatterji and N. L. Sharma.

PROBLEM OF COAL INDUSTRY

PRESIDING at the Second Annual General Meeting of the 'Coal Consumers Association of India' in Calcutta on November 20, last Mr D. C. Driver said that the parrot cry that because Britain has nationalized her coal industry, India should do the same should be stilled for some time for obvious reasons, *viz*., that after nationalizing the mines in Britain, the production has gone down, costs increased, labour indisciplined and out of control.

The Central Provinces were launching on an experiment of working the Kamthi coal fields and the results will be watched with interest. The depletion of India's finances owing to the division of the country and the colossal expenditure on rehabilitation of refugees would not permit any outlay of expenditure for such sentimental shibboleths like nationalization.

Continuing Mr Driver stressed the formation of a 'Ministry for Fuel' as recommended by the Indian Coalfields' Committee (1946), in order to bring matters relating to coal under one authority, so that coal interests may not be shoved on from pillar to post, from one Ministry to another for the redress of their grievances.

Referring to the subject of research in coal, Mr Driver pointed out the inadequate staff and funds available to the Fuel Research Committee. The results achieved so far are still immature for publication of results. The results on Coal Washing Research, however, should now be made available for the information of producers and consumers. Mr Driver further suggested sending out young scholars and experienced men, for training in coal beneficiation and coal combustion in U. K. and U. S. A., and for studying the technique of underground gasification to U. S. S. R., Germany and Belgium, respectively.

RADIATION METER FASTER THAN GEIGER COUNTER

A METER that counts fragments from exploding atoms 50 times as fast as a Geiger counter has been developed at the Westinghouse Research Laboratories. Able to tally 100,000 particles a second, the new instrument can be used for such jobs as measuring how fast some nuclear materials lose their radioactivity.

Geiger counters contain a gas that atomic particles will ionize or break up into charged gas atoms that conduct electricity. This ionization permits a surge of electricity to flow through the tube and trip a counter. So long as the particles arrive at a reasonable speed—less than 2,000 per second—the Geiger tube counts each one. But above that rate the gas cannot ionize and de-ionize fast enough to keep up with the incoming particles and the tube loses count, giving a steady current instead of individual surges.

This new device, uses a different principle providing clear counts up to 100,000 per second. It has a fluorescent screen, a spherical mirror, and the multiplier photoelectric cell, connected to amplifying and counting circuits. (See *Popular Science*, October, 1947, p. 131)

ATOMIC ENERGY BOARD

THE Board of Research in Atomic Energy set up by the Government of India (see SCIENCE AND CULTURE, September, 1947, p. 100), will in addition to the six members already announced, include also Dr D. M. Bose, Dr J. N. Mehta and Sir K. S. Krishnan.

The functions of the Board are (1) to plan, finance and carry out atomic research and development throughout India; (2) to explore the availability of raw materials connected with the generation of atomic energy and to advise the Government on the control, utilization and export of such raw materials in India; (3) to provide the machinery for co-operation on matters of atomic energy research and development with the corresponding bodies and to advise the Government on any agreement with foreign powers that may be necessary for the purpose and (4) to appoint committees and to take all other steps in furtherence of the aim of developing atomic energy.

A large number of research schemes have been sanctioned for research in Atomic Energy including grants to the Tata Institute of Fundamental Research for study on cosmic rays and for training a team of workers in research; to Prof. M. N. Saha of Calcutta University for establishing a centre of Nuclear Research and Biophysics; and to the Bose Research Institute, Calcutta. A total sum of Rs. 2,50,000 has been sanctioned for research on these schemes.

NEW NUCLEAR REACTIONS UNDER HIGH ENERGY BOMBARDMENT

THE new cyclotron of the University of California's Radiation Laboratory has a magnet of 15⅓ feet in diameter and it weighs 4,000 tons, the earlier one weighed 225 tons. This giant cyclotron has pro-

duced bombarding beams with energies 10 times greater than ever before. In the course of a pure research programme sponsored by the U.S. Atomic Energy Commission, the College of Chemistry and the Radiation Laboratory, both of California University, have recorded very complex nuclear disintegration processes with beams of deuterons and helium ions of approximately 200 and 400 mev respectively which have been produced in the above cyclotron. Disintegrations have yielded 22 particles from a single atom including both neutrons and particles of positive charge, and many new light isotopes were obtained in the process of disintegration. Arsenic bombarded with alpha particles yielded isotopes of all elements from selenium to manganese. Even chlorine isotopes have also been detected. The detection of chlorine means a series of 16 elements down the table. This big jump suggests alternate routes by which arsenic may be converted into chlorine. Previously ejection of one or two neutrons from the nucleus yielded a route to a transmutation process, but the case of chlorine opens up new lines of attack. Bombardment with the high-energy particles in case of iodine has given heavier isotopes. Iodine isotopes of I[illegible] and higher have been obtained but the stable isotope is I^{127}. By bombarding copper an unstable isotope of iron, Fe^{52} has been produced with a half-life of 8 hours. The Fe^{52} emits positron. Reactions of both multiple neutron ejection and multiple charged particle ejection have been observed to take place, and photographs of 3 to 5 particle-disintegration of light elements have been obtained. (*Chem and Eng. News*, 25, 2144, 1947.)

MANUFACTURE OF CHEAP RADIO SETS

The progress of scientific research made in India for the manufacture of cheap radio sets for the people was referred to in reply to a question in the Central Legislative Assembly by the Hon'ble Dr S. P. Mookerjee, Minister for Industry and Supply.

According to his statement, research work on schemes financed by the Council of Scientific and Industrial Research, relating to "manufacture of Condensers and Resistances" and "manufacture of Loud-speakers" has been completed, and non-technical notes have been prepared for the commercial utilization of the results obtained. Research on the "design of cheap radio sets" has also been completed, and the question of commercial utilization of the results obtained is being taken up by the Council. Research on the "manufacture of Radio Valves" is being financed at the University College of Science, Calcutta. A pilot plant has been imported from America for this purpose and the experiments are still in progress.

The Panel on Electrical Machinery and Equipment has made recommendations with regard to the manufacture of cheap radio sets in India, which are now under the consideration of the Government.

At present only assembly of radio sets from imported radio components is possible. Attempts are, however, being made to manufacture as many radio components as possible, and it is hoped that in the next five years India will be well on her way to self-sufficiency in this regard. No highly specialized machinery is required for the manufacture of the majority of the radio components needed, and this machinery can be manufactured in India.

There are at present two firms in India which assemble electric mains operated radio sets. One of them is manufacturing what is popularly called the "People's Set", the price of which is Rs. 95/-.

HEN'S EGGS IN CLINICAL USE

Hen's eggs are supplementing the role of the guinea pig and the mouse (the white variety called, albino rat), in the hands of the medical research workers. In the fight against yellow fever, typhus and influenza vaccination with the specific virus has yielded good results. A living culture medium is necessary to cultivate a specific virus. And chick embryo or popularly known as hen's egg is an almost ideal medium, appearing to harbour no naturally occurring viruses. The embryos are injected with the virus through a puncture in the shell and when the virus has multiplied, the embryos are removed from the egg shells and then successively ground, filtered, frozen and dried. Before vaccination a calculated amount of water is added to the material. Yellow fever vaccine has been made in Rockefeller Foundation Laboratories in U.S.A. and influenza vaccine in Australian Laboratories. Hen's eggs also provides an aid to diagnosis in the fact that the appearance of chick embryo tissue infected with different viruses varies considerably from one virus to the other. Besides viruses, bacteria and protozoa which cause diseases in man and in domestic animals have been successfully cultivated in the chick embryo.

FERTILIZERS FOR FISH FARMING

On land the farmers have been able greatly to increase their crops by the addition of mineral salts which were found lacking in the soil. Experiments in lakes with artificial fertilizers in fish farming have now been carried out in Scotland and in Canada, and the results are promising. Fishes live partly on small animals and partly on microscopic plants which live either suspended in the water or lying on the surface of the mud. The plants which form the ultimate

organic source of the fishes' food depend for their growth upon the presence in the water of certain elements, in particular nitrogen, phosphorus and potassium in the form of soluble salts, such as nitrates and phosphates. But it is obvious that the application of fertilizers to fishing grounds of the countries, namely, the seas does not lend itself to such development by commercial concerns. The Governments can alone undertake the task of finding out whether the sea fishery of the world should not reach the threshold of a new expansion.

NEW BACTERICIDE FOR SURFACE INFECTIONS

Research at the University of California Medical School has discovered a new bactericide for surface application which claims to have equal potency as Penicillin. It is not meant for internal treatment. Sensitization of the skin is absent with this drug and therefore its application will be preferred to penicillin. It has been named Cramicidin. Originally it had two handicaps; it destroyed red blood corpuscles and had difficulty in dissolving in water. A chemical derivative of the original product has eliminated these two defects. It has been obtained in crystalline form but its chemical formula is not yet known. The material is of the nature of peptide derived from common amino acids having much smaller molecular weights than proteins.

CONTINUOUS CHARCOAL MANUFACTURE

The Polytechnic Institute of Brooklyn has invented a continuous charcoal manufacturing process which has greater efficiency and gives better quality of products. The plant consists of a vertical oven into which from top the wood of proper size is continuously fed by means of an air-tight loading device. Pyroligneous acid is allowed to slip down in the oven, and against this current a stream of inert gas rises upward through the wood surrounding it and heating it to the carbonization temperature. The gas leaves the oven at 212°F and the finished hot charcoal is withdrawn from the bottom of the oven by means of a special device. The resulting products of distillation, tar, wood alcohol and acetic acid vapours, rise to the top and are drawn off together with the circulating gas. Part of the circulating gas is recirculated and the rest passes out into the atmosphere.

MAXIMUM EXTRACTION FROM OIL WELLS

In order to ensure maximum extraction, a co-operative plant is under construction which is jointly shared by 16 Louisiana oil producing companies, for processing the oil well residues. The new plant is estimated to extract 70,000 gallons per day of liquid hydrocarbons from the abandoned oil wells. The liquid hydrocarbons will include, propane, butane and natural gasoline too. After the extraction of the liquid products, the remaining dry gas will be sold as ordinary gas fuel in conjunction with a gas company. Interests and right of the member-companies are in the proportion of their ownership in the total producing area.

THE DAMODAR VALLEY CORPORATION

The West Bengal Legislative Assembly in its first sitting unanimously adopted the constitution of the Damodar Valley Corporation as recommended by the Central Technical Power Board of the Government of India and already legislated in the Central Legislature and the Bihar Legislature. The corporation will consist of three members including a chairman. The members will be appointed after consultation with the Governments of Bengal and Bihar, by the Central Government. The main objects of the corporation have been declared as follows:—

(a) To provide and operate schemes for irrigation and water-supply for agricultural, industrial, domestic and other needs.

(b) To provide and operate schemes for the generation, transmission and distribution of electrical energy.

(c) To provide for the flood control of the Damodar River.

(d) To facilitate navigation of the Damodar River and to aid in the improvement of the port of Calcutta and flow conditions in the Hooghly.

(e) To facilitate afforestation, control of soil-erosion and proper use of land in the Damodar basin.

(f) Generally, to encourage agricultural, industrial, social, public health and economic development of the Damodar basin.

The Corporation will have power to do anything which will facilitate the furtherance of the aforesaid objects and will have power also (a) to acquire, purchase or lease and hold movable and immovable property and to dispose of such property, (b) to construct dams, barrages, power houses, navigation works and irrigation, navigation and drainage canals required for the unified development of the river system; (c) to undertake or co-operate in the re-settlement of the population, displaced by the construction of the dams; (d) to aid in the establishment of Co-operative Societies whenever required for the better use of the facilities made available by the Corporation, (e) to prevent population of water under its control; (f) to undertake measures to prevent malaria; (g) to stock its reservoirs or water courses with fish and to prohibit unlicensed fishing.

In constructing canals, the Corporation will have to secure the consent of the Provincial Government.

The Corporation will, after consultation with Provincial Governments determine and levy the rates for the bulk supply of water for irrigation and fix the minimum quantity of water, which can be made available. The rates at which such water is supplied by the provinces to cultiva-

r, shall be fixed by the provinces concerned after consultation with the Corporation.

The Corporation will have power to determine the tariff for supply of water for industrial or domestic purposes.

The Corporation will have power to levy fees for navigation.

The Corporation will have the exclusive right to sell electrical energy to any person including Provincial Government, within the Damodar basin, where such electrical energy is taken by a consumer at a pressure in excess of 30,000 volts.

In the Inter-Provincial conference held on 6th January, 1947 in New Delhi in connection with the Damodar Valley Project, it was generally agreed after consideration of financial analysis given by Mr Voorduin, in his preliminary memorandum that the allocation should be as follows :—

(a) *Power*—All the three Governments of Bengal, Bihar and Centre should take equal shares in the capital expenditure on this account (Mr Voorduin estimates the expenditure roughly at 28 crores).

(b) *Irrigation* Bengal and Bihar should take shares in proportion to the benefits which they are likely to receive. (The rough estimate of expenditure according to Mr Voorduin is 18 crores)

(c) *Flood Control* The capital expenditure estimated by Mr Voorduin at 14 crores, should be shared half and half between Bengal and the Centre, subject to the condition that Centre's contribution should not exceed 7 crores. The recurring expenditure on flood control is to be borne entirely by the Bengal Government.

No revenue is likely to be derived on account of flood control. Gains to Bengal will be indirect. The Provincial Government won't have to spend money for repairs of embankment, damaged by flood and for undertaking relief operations in the flood affected areas. The people will be saved from individual loss of property of cattle, of houses, of grain and fodder stocks, etc. The annual recurring costs of flood control including interest at 3 per cent depreciation, operation, maintenance and administration will be a substantial sum. The loss in respect of flood control will have to be borne entirely by the Bengal Government. The other two Governments will have no share in the deficit.

The revenue from power and irrigation is, however, estimated to yield a net profit after paying for the expenditure. The net profit attributable to power and irrigation will be credited to the three Governments in proportion to their respective shares in the total capital cost attributed to this purpose. The net deficit in respect of any purpose shall be made good by the Governments concerned in the same proportion.

35TH SCIENCE CONGRESS AT PATNA

The 35th annual session of the Indian Science Congress Association will be held at the Science College Buildings, Patna, from January 2 to January 8, 1948. Col. Sir Ram Nath Chopra, President of the Indigenous Systems of Medicine Committee, will preside over the session.

A special feature of the Patna session of the Science Congress will be the visit, as on the last occasion at the Delhi session, of a delegation of top-ranking foreign scientists from Great Britain, France, Norway, Denmark, Hungary, America, Russia and possibly also from some countries in Near, Middle and Far-East. Invitations have already been extended to scientists of international renown such as Prof. A. Einstein (America), Prof. Niels Böhr (Denmark), Robert Robinson and Sir Edward Appleton (England), Prof. Peterssen (Norway), Prof. Szent Gyorgyi (Hungary), Prof. Englehardt (Russia), Dr Vannever Bush (America), Prof. Curio-Joliot (France), etc. The Government of India have made a grant of Rs. 75,000 to the Indian Science Congress to meet expenses in connection with the visit of the foreign scientists to India. Scientists from Burma, Ceylon and Afghanistan have expressed their desire to attend the 35th Annual Session.

Dr B. Narayana and Dr P. B. Ganguly are the local Secretaries. All enquiries regarding local arrangements and accommodation, etc. should be addressed to the local Secretaries, 35th Indian Science Congress, Science College, Bankipore, P.O. Patna. The following are the sectional presidents:

Mathematics—Dr R. Vaidyanathaswamy, Reader in Mathematics, Madras University.

Statistics—Mr S. N. Ray, Lecturer in Statistics, Calcutta University.

Physics—Dr L. A. Ramdas, Director, Agricultural Meteorology, Poona 5.

Chemistry—Prof. B. Sanjiva Rao, Professor of Inorganic Chemistry, Indian Institute of Science, Bangalore.

Geology and Geography—Dr P. K. Ghosh, Deputy Director, Geological Survey of India, Calcutta.

Botany—Dr K. A. Choudhury, Wood Technologist, Forest Research Institute, Dehra-Dun.

Zoology and Entomology—Prof. A. B. Misra, University Professor of Zoology, Benares Hindu University.

Anthropology and Archaeology—Dr A. Chatterjee, Lecturer in Anthropology, Calcutta University.

Medical and Veterinary Sciences—Dr G. D. Bhalerao, Director, Indian Veterinary Research Institute, Izatnagar.

Agricultural Sciences—Rai Bahadur Kali Das Sawhney, M.Sc., Director of Agriculture, Hyderabad (Deccan).

Physiology—Dr Bashir Ahmad, Director, Panjab University Institute of Chemistry, Lahore.

Psychology and Educational Science—Dr Zakir Hussain, Principal, Jamia Millia Islamia, Jamianagar, Delhi.

Engineering and Metallurgy—Mr N. Sen, Chief Chemist, Tata Iron & Steel Co., Ltd., Jamshedpur.

INDIAN INSTITUTE OF METALS

A TECHNICAL association representing the metallurgical profession in India, would be inaugurated by Dr S. P. Mookerjee, Minister for Industry and Supply, on December 29 next at the Royal Asiatic Society of Bengal, Calcutta. Sir Jehangir Ghandy, Director of Tatas, will deliver the presidential address.

The objects of the Institute would be to promote the interests of the profession and industry, to encourage researches, to facilitate training in metallurgy, to publish a journal, etc.

The headquarters of the Institute will be at Jamshedpur, with branches at important industrial centres. Further information may be had from Sri P. C. Ghosh, 128 Straight Mile Road, Jamshedpur.

BANGIYA BIJNAN PARISHAD

An association, called the *Bangiya Bijnan Parishad*, will be formally inaugurated in Calcutta on January 25, 1948. The association was formed at an informal conference of scientists and Bengali writers on scientific subjects held at the University College of Science and Technology, Calcutta, on 18 October last, on the invitation of Prof. S. N. Bose, Khaira Professor of Physics, Calcutta University.

The object of the association is to help science students and teachers to tide over the initial difficulty likely to be experienced by the adoption of Bengali as the medium of instruction at all stages of education. With this object in view the association has undertaken the task of publishing a popular quarterly scientific journal in Bengali for school and college students.

The annual subscription for membership of the association is rupees ten, and members are being enrolled by Dr S. N. Bagchi, Secretary of the association, 92, Upper Circular Road, Calcutta, 9.

We wish the organizers all success in their laudable venture.

NOBEL PRIZE IN CHEMISTRY

Sir Robert Robinson has been awarded the Nobel Prize in Chemistry for the year 1947.

Sir Robert has been serving the University of Oxford as Waynflete Professor of Chemistry since 1930, was knighted in 1930 for his work on synthesis and was elected President of the Royal Society in 1946. One of the foremost organic chemists in Great Britain today, Sir Robert is an authority on the synthesis of natural compounds. Sir Robert was trained under the late Prof. W. H. Perkin in the chemistry of the alkaloids. He carried out investigations on the structure and synthesis of anthocyanin, (the colouring matters of flowers, and fruits, and has developed the theory of biogenesis of plant products. He also elucidated the formula for morphine, and carried out synthesis of secondary sex hormones that attracted wide attention. (See Science and Culture 11, 478, 1946). The award is made for Sir Robert's investigations of biologically important plant products, especially alkaloids.

A fuller account of Sir Robert Robinson's career is expected in the next issue of our journal.

ANNOUNCEMENTS

Sir Jnan Chandra Ghosh, Director, Indian Institute of Science, Bangalore, and Editor, Science and Culture, has been appointed Director-General of Industry and Supply, Government of India.

Sir Shantiswarup Bhatnagar, Director, Board of Scientific and Industrial Research, Government of India, is appointed to act as Secretary, Ministry of Education, in addition to his own duties, *vice* Sir John Sargent, granted leave for a year and a half.

Dr P. C. Mahanti, Lecturer in Applied Physics, Calcutta University, has succeeded the late Prof. P. N. Ghosh as Sir Rash Behary Ghosh Professor of Applied Physics of the same university.

Dr B. D. Nag Chaudhury, Reader in Nuclear Physics, Calcutta University, has been deputed by the Government of India to Europe and America to acquaint himself with the developments and latest technique of nuclear physics.

Prof. B. Sahni, Director, Institute of Paleobotany, Lucknow, has been deputed by the Government of India, for a study tour of the U. S. A., Canada and U. K. Prof. Sahni left India on October 20 last.

BOOK REVIEWS

A Text Book of Physical Chemistry—By N. C. Sengupta and K. C. Sen. Pp. vii+525. Mondal Brothers & Co. Limited, Calcutta. 1947. Price Rs. 10.

As the authors say the book is "primarily intended for the B.Sc., students both pass and honours of the various Indian Universities". Admittedly, the book will serve its purpose well. The reviewer, however, cannot agree with the author's claim that the students of chemical engineering will find the book entirely suitable for them. There may be differences of opinion in the treatment of subject matters, but the one made in the present volume is justified for a text-book of the standard selected. The arrangement of matters can be similarly viewed in different ways and the reviewer feels that chapters Fourteen and Fifteen should better come after chapter Three.

Theoretical principles are better understood if their applications are demonstrated by means of suitable numerical problems. The large number of problems, some of which are worked out at the end of each chapter, as well as the hints for practical work have in this respect enhanced the value and merit of the book. Wise judgment has been employed by the authors to treat most of the topics at their proper levels, at the same time economising space.

There are some obvious lapses which the authors will surely take care to correct in the next edition of the book. The symbols for ionic strength and frequency require to be made to look more like the usual ones.

S. K. M.

Van Nostrand's Scientific Encyclopaedia—Second Edition. Pp. 1,600 and 3 plates. Published by D. Van Nostrand Company Inc., New York. Price £3 5s. net.

The book under review is the second edition of a similar volume published earlier and as mentioned in the preface some new sections on Electronics and Radio Metallurgy, Meteorology, Photography and Statistics have been added. This volume now deals with the important terms and words used in twenty different subjects, *e.g.*, Aeronautics, Astronomy, Botany, Chemical Engineering, Chemistry, Civil Engineering, Electrical Engineering, Geology, Mathematics, Mechanical Engineering, Medicine, Mineralogy, Navigation, Physics, Zoology and the five subjects mentioned above. The principal terms and words used commonly in these subjects have been included and besides the meaning of the words, short articles explaining the objects to which the words refer have been given in the case of most of the words. These articles are in many cases illustrated.

The different topics in Aeronautics dealt with are: aerodynamics, aeronautical engines, airfoil (including theoretical discussion regarding the lift), airplane fuselage, air propellers, airship, ground effect, rockets, jet engines, airplane wings, aircraft de-icers, autogyro, automatic pilot, etc. A historical account of artificial aerial heights has been given and a photograph of atomic bomb explosion at Nagasaki on August 9, 1945 has been reproduced in the frontispiece. The articles on topics in Astronomy are not large in number and they are not well illustrated. Only some principal constellations and planets have been mentioned. On the other hand the articles in the sections of Botany, Zoology and Geology are numerous, fairly exhaustive and illustrated with the help of beautiful photographs. These will be useful even to the specialists in these subjects. The articles on Chemical Engineering are useful, although they are not large in number. In some of these articles interesting illustrations have been included. The articles on Chemistry are large in number and exhaustive. The special feature of the articles in this section is the inclusion of numerous tables each of which includes the chemical formulae and other important data regarding a particular series of compounds, *viz.*, organic acids, hydrocarbons, amines, alkaloids, etc. There is an article on history of evolution of chemistry which deserves special mention. Some valuable information has been included in this article.

The topics on Physics and Electronics and Radio dealt with in this volume cover a wide field in each of these two subjects and they seem to be quite up-to-date. In the latter section most recent discoveries have been incorporated. For instance, some information regarding the principles and applications of Radar and Klystron can be found in this section. The articles on Mechanical Engineering also cover a very wide field of the subject and they are suitably illustrated. These articles relate to workshop appliances such as tools, machines, jigs,

etc., railway appliances, pumps, compressors, engines, turbines, bridges, columns, trusses, etc. The articles on Electrical Engineering seem to be elementary although these are numerous and well illustrated.

The articles in the sections of Mathematics and Statistics are brief, but they relate to advanced courses of these subjects. The articles on Medicine are particularly interesting, because some beautiful illustrations including a few coloured plates have been included. The names and symptoms of most of the diseases have been given. These seem to have been written by authorities on the different branches of the subject and will be useful not only to the medical profession but also to the common householder.

The usefulness of this volume can hardly be overestimated. It will be useful to a wide circle of scientists, to the editorial staff of journals dealing with popular or specialised scientific articles and even to the educated lay man. In this age of scientific development the common man is confronted with scientific terms and phraseology very frequently in his daily life The possession of such an Encyclopaedia will not only enable him to enrich his knowledge but may also save him occasionally from mis-misfortune. For instance, if a case of Typhus occurs in his family, his consulting physician may be negligent, but if he consults this volume he will find that at one stage haemorrhage from intestines and stomach proves fatal in some cases of Typhus, and he may take proper precaution. This volume will certainly find a wide circulation and every one interested in it will find it worth the price.

S. C. S.

Elements of Tropical Soil Science—By T. Eden, D.Sc., Agricultural Chemist, Tea Research Institute of Ceylon, Macmillan & Co. Ltd., 1947. Price 5 sh.

The book deals with the subject in nine chapters as follows.—

I. The Soil, its origin and formation.
II. The Physical properties of soil.
III. The Chemical properties of soil: the mineral portion.
IV. The Chemical properties of soil: organic matter and humus.
V. Green manuring and compost.
VI. Cultivation.
VII. Soil erosion and drainage.
VIII. Fertilizers and their use.
IX. Field experiments.

It is a very readable book, which has presented the subject lucidly. It, however, deals not so much with soil science, in its strict sense, as its applied aspects and with the special problems met with in the tropics incidentally. Controversial subjects, such as organic manures versus inorganic fertilizers, green manures versus compost, have been discussed in a balanced manner.

The book can be safely recommended to agronomists and soil workers as also laymen interested in agriculture. It would also be very useful for beginners taking a course in agriculture.

J. N. M.

Calcutta Statistical Association Bulletin, August, 1947. Published by H. Chatterjee & Co. Ltd., Calcutta. Price Rs. 1-8

In modern society statistics has become an indispensable tool for statecraft. It is the only scientific method available for studying mass phenomena and as such its importance for dealing with social problems cannot be over-emphasised. The Free India of to-day is faced with the stupendous task of building a new society for hundreds of millions of men, and to fulfil this task the need for proper statistical knowledge is urgent. We, therefore, welcome the appearance of the Bulletin of the Calcutta Statistical Association. The Association itself was started in 1945 as a registered, learned Statistical Society under the initiative of the members of the staff of the Calcutta University Statistics Department. It is indeed a happy augury that the society will have the closest collaboration with the University, so that the public will have the benefit of scientific statistical knowledge. The dissemination of statistical knowledge among the general public of this country is an important task and we are happy to note that the sponsors of the Bulletin have devoted particular attention to it The first number contains articles on important current problems such as Crop Estimation, Survey of Public Opinion and Critique of the Pay Commission's Report. The articles are written in a form that will immediately appeal even to the layman. It appears that the Bulletin is purposely devoted, and rightly so, to dealing with practical problems of the day. The need for such a publication has been felt for a long time and we must congratulate the Calcutta Statistical Association for rendering this valuable service to our community. The Bulletin also contains research notes which, although highly theoretical, have direct practical application to many social and economic problems. We hope the Bulletin will have a wide circulation and wish the Association every success in its new venture.

K. C. B.

Radioactivity and Nuclear Physics—By James M. Cork. Publisher: D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York. Pp. 313. Price 22 shillings.

Nuclear Physics is a subject of very recent growth, and developing rapidly since the discovery of Neutrons in 1932. The information about the subject are mostly scattered in the journals of learned societies and the want of a comprehensive compilaton of this expanding subject is acutely felt.

The author has made an attempt to introduce the subject to a beginner in this book. Compared to the few other books on this subject, *viz.*, F. Rasetti—Elements of Nuclear Physics, N. Feather—An Introduction to Nuclear Physics, J. Hoag—Electrons and Nuclear Physics, etc., the present book is a better presentation as it encloses the most recent developments on the subject (*e.g.*, Betatron, Synchrotron, Pile, etc.) and covers a wider field.

There are altogether twelve chapters dealing with Natural Radioactivity, Detection of Radiation, Induced Radioactivity, Apparatus, Alpha Rays, Beta Rays, Gamma Radiation, Neutrons and other Fundamental Particles of Cosmic Radiation, Nuclear Fission and ends with some applications of Radioactivity. Of these, the chapters on Induced Radioactivity, Beta Rays and on Nuclear Fission are specially well written and furnish the beginner with the latest information on these topics in a very neat and lucid way.

A few words on Gamow's Theory of Alpha-Ray Disintegration, Mattauch's Mass-spectrometer and on the experiment on Beta-Gamma and Gamma-Gamma coincidences would have been appreciated and a specific chapter dealing with the Energy level schemes of the unstable Radioactive Nuclei and their modes of transition to the stable states along with a schematic diagram of the same would be welcome in the next edition.

The pictures and illustrations are fairly well done. Mathematical formulae are often reported without proof, while detailed referrences are given to original papers. The value of the book is much enhanced by the Appendix which contains the latest data on a fundamental physical constants. Questions and problems are appended at the end of each chapter. The book is to be recommended highly to the beginners and the degree students.

M. N. S.

What Is Mathematics?—By Richard Courant and Herbert Robbins. Published by the Oxford University Press. Pp. 521. 3rd Edition. Price *27s. 6d.*

This book is sure to receive a most warm welcome from every person interested in mathematics. It has been written to give an elementary approach to ideas and methods of mathematics, and it fulfils that aim in a splendid manner. A student may very well start reading the book with a knowledge of mathematics hardly above the high school standard, but as he goes through the book he will be continually passing through many beautiful and fascinating portions of mathematics, and forming intimate acquaintance not only with the formation and the rigour of pure mathematics, but also with the various practical applications of mathematical theorems. All through the book the authors have tried to give stress on a real understanding of the essence of mathematics, "the life blood of our science" as Herman Deyl puts it, rather than on an empty and routine drill in problem solving. The reader is led from elementary facts and fundamental ideas to vantage points from which the driving forces of modern mathematics can be surveyed.

The book in all contains eight chapters, which may be broadly classified as follows. The first two chapters are on arithmetic and algebra with a very brief introduction to Boolean algebra; then comes an outstanding chapter on the impossibility of certain geometrical constructions in which the notion of algebraic field is introduced; the fourth and fifth chapters are assigned to geometries and topology respectively; the rest are on analysis and calculus. The text is illustrated with nearly 300 diagrams, and much of the clarity arises from a generous use of geometrical interpretations. A chapter on group theory, or at least a few articles on permutation groups, and some more matter in the article on different equations would have been most welcome additions to this very enjoyable book.

U. K. G.

LETTERS TO THE EDITOR

[The Editors are not responsible for the views expressed in the letters.]

SIGNIFICANCE OF PROTEOLYTIC INHIBITOR IN THE LOW NUTRITIVE VALUE OF LEGUMINOUS PROTEINS

CONSIDERABLE interest has recently been focussed on the increase in the biological value of certain proteins after sufficient heat treatment. Osborne and Mendel[1] first found that heating increases the nutritive value of soya-bean protein and they thought that by cooking the palatability of the product is increased and thereby inducing the rats to consume more of the food with a resulting gain in weight. The nutritive value of phaseolin, the isolated protein from navy bean, has been studied by Osborne and Mendel[2], who found that animals failed to grow under phaseolin feeding and died in a relatively short time. McCollum *et al*[3] also observed the same thing with navy bean meal when this constituted the only source of protein in the diet. They attributed the failure of the navy bean to promote growth to the presence of hemicellulose. Johns and Finks[4] found that phaseolin is rendered into an efficient food by heating it with water. They therefore postulated that heating may either cause some molecular rearrangement to occur in the very complex and probably labile protein molecule thereby making it more readily digestible or bring about the destruction of some unidentified toxic factor present in phaseolin. Miller[5] isolated a toxic substance, 3-4 dihydroxyphenylalanine, from the seed of the Georgia velvet beans. Finks and Johns[6] however found that the isolated proteins prepared by dialyzing their saline extract are no better tolerated than the bean meal, but the protein obtained by coagulation gave normal growth. From the experimental evidence the hypothesis put forward by them is that the proteins in the raw state as prepared by dialysis are not sufficiently digestible for animal nutrition, while the coagula were sufficiently cooked by boiling to render them digestible. Waterman and Jones[7] also found that phaseolin is rendered more readily digestible by boiling with distilled water. The improvement in the digestibility and the biological value of certain of the legume proteins has been observed by Acharya *et al*[8]. From the above findings, one is apt to believe that heating causes some change in the structure of the protein molecule thereby rendering it more digestible and nutritive.

But Bowman[9], for the first time has shown that soya bean and navy bean contain a fraction which inhibit the *in vitro* digestibility of milk casein by trypsin and they have postulated that its presence may account for the low nutritive value of raw soya and navy beans. Ham *et al*[10] also found such an inhibitor in soya bean and they postulated that the destruction of the proteolytic inhibitor may partially explain the high nutritive value in the autoclaved soya bean. De and Ganguly[11] found that gylcin, freed from proteolytic inhibitor in the course of preparation, is more nutritive than autoclaved soya bean.

The present study was taken up to see whether all the leguminous seeds which show higher nutritive value on heating contain this proteolytic inhibitor or not. For this an acid extract (pH 4.2) of the various beans was prepared and added to a digestion mixture containing 50 cc. of 5 per cent soluble casein with 2 cc. of 0.5 per cent pancreatin and 10 cc. of 0.8 M phosphate buffer (pH 8.0) and incubated at 37°C. for 8 hours.

The following results were obtained with different beans.

Extract employed	% of the total protein undigested
Casein control	6·1
Wheat	8·4
Rice	10·1
Soyabean	94·6
Navy bean	92·7
Velvet bean	86·2
Bengal gram	64·0
Green gram	62·1
Black gram	50·4

The above results show that all the leguminous seeds contain the proteolytic inhibitor in varying proportions, soya, navy and velvet beans containing relatively large proportions of the inhibitor. These beans show sufficient improvement in their nutritive value after heat treatment whereas the nutritive value is improved to a small degree in the case of Bengal gram, Green gram and Black gram after heat treatment. From these observatons, it may be postulated that the improvement in the biological value found in leguminous seeds is due mainly, if not entirely, to the destruction of the proteolytic inhibitor present in them.

Our best thanks are due to Prof. V. Subrahmanyan for the keen interest in the work.

S. S. De
M. G. Sastry

Department of Biochemistry,
Indian Institute of Science,
Bangalore, 10-5-1947.

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A RIGOROUS PROOF OF THE INCOME DISTRIBUTION OF PARETO

The famous Pareto's income distribution function was discovered by him when he plotted the cumulative distribution of incomes on double logarithmic scale and found that the resulting graph was a straight line. Some writers[1] think that the law may not be applicable in all countries during all times. It is the object of this note to point out the exact conditions under which the law holds or does not hold. Kalecki's generalization[2] of the Gibrat approach will throw light upon this problem. Certain variates (*e.g.*, the number of workers in a factory or the income earned by individuals) are subject to a series of shocks, either random or economic. Gibrat[3] established that the logarithms of such variates are normally distributed, assuming that the standard deviation increases merely under the influence of random shocks. Kalecki proves that the same law holds even when (*i*) the standard deviation is kept constant by the action of economic forces and (*ii*) the change in the standard deviation is fully or partially determined by economic forces.

Let X be the variate and Y denote the devation of log X from the mean of log X. Then Y is naturally log X/G, where G is the geometric mean of X. Let Y denote the deviation of the logarithm of the ratio of the variate between two successive periods, from the mean of these logarithms. If y and Y are connected by a relation of the type $y=\Phi(Y)+C$, the distribution of $\Phi(Y)$ will approach normality provided the change in the second moment of Y is throughout of the same order as $\Sigma y^2/N$. This has been established by Kalecki. Considering the particular case $\phi(Y) = \log X$ he has also fitted the resulting curve to the distribution of incomes in U.S.A.; but he finds that this by itself does not give a good fit and adopts $\phi(Y) = \text{Log}(X\text{-}A)$. Instead of this if we put $\phi(Y) = (\text{Log } Y)$ we get on simplification the Pareto's function which has proved to be a good fit for the income distributions of various countries at various times.

For

$$N = K\,e^{-B(\log X^{\frac{1}{2}})^2 - C}$$
$$= K\,e^{B \log X - C}$$

i.e., $\log N = -B.\log X +$ a constant.

This distribution is naturally approached under the same conditions as before. Further any generalization of the Pareto's distribution can be made by taking different functions of Y, *i.e.*, considering suitable functional forms of $\Phi(Y)$. Thus we have the Pareto's distribution on a rigorous mathematical foundation, adopting the generalized Gibrat distribution.

V. S. Ananthachar

1464, K. Puram,
Mysore,
30-7-1947.

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KEW AND INDIA

Chatterjee[1] in his article entitled "Royal Botanic Gardens, Kew" stated that "The main work should be the authentication of Indian herbaruim sheets with so many thousands of type sheets of Indian plants which are lodged at Kew" and "In view of the above, and as a first step towards building a *National Herbarium in India*, the collections of some important Herbaria in India should be sent to Kew for authentication with the type sheets. . . . Unless this is done at an early date the superstructure of the Botanical Survey cannot be built", are seriously

regarded to cast vicious aspersions on the work and the management of the Indian herbaria. "Some important Herbaria in India" in the above excerpt brings to my mind only the three foremost herbaria in India, in their chronological sequence and in order of their importance, *viz.*, the Royal Botanic Garden, Sibpur (1832), Coimbatore (1874) and Dehra Dun (1898). Further analysis of the remarks in the above quotation, brings out clearly that the attack was definitely aimed at the oldest institution in India, *i.e.*, the Sibpur Herbarium, Calcutta, in as much as the special committee appointed by the Botany Section of the Indian Science Congress Association at its Jubilee Session, held in Calcutta on 6th January, 1938, had agreed that the Sibpur Herbarium was the most suitable for being developed into the *National Herbarium for India*. It will be interesting to know that one of the signatories to this resolution on the National Herbarium was the late Sir Arthur Hill, a former Director of the Kew Gardens, London.

With what motive Dr Chatterjee has thought it wise to call in question the authenticity of the identifications of the collections in Sibpur and other herbaria in India or whether it was only his apparently exuberant solicitude for building 'the superstructure of the Botanical Survey of India", which, I may say without such gratuitous solicitude, but under the able directions of Sir George King, Sir David Prain, Lt.-Col. A. T. Gage and their successors has from 1890, stood its ground against the vicissitudes of time, finances and inadequate appreciation of its values, it is impossible to say. The collections in the Sibpur Herbarium alone number nearly four millions. C. B. Clarke, F.R.S., Sir J. D. Hooker, F.R.S., Salpis Kurz, T. Anderson, F.R.S., Sir George King, F.R.S., Sir David Prain, F.R.S., A. T. Gage, J. S. Gamble. S. T. Dunn, J. R. Drummond, W. C. Craib, Sir William Wright Smith, F.R.S., H. H. Haines, C. E. C. Fischer and many monographers of recent times like Engler, Diels, C. K. Schneider, Holtum, Burkill and others have all examined the collections of Sibpur and have left their marks on them. As a result of my thirty-one years' work and experience in the Sibpur Herbarium, I can say that almost every sheet in Sibpur, which belong to the collections of the nineteenth century, bears the impress of either Sir George King or Sir David Prain, whose fame and work in Systematic Botany are too well known to need comment from me.

Speaking about types of earlier species Chatterjee says that they are all scattered in different herbaria of the world. How then does he expect to have them all at Kew? Would he enlighten the Indian scientific world about the whereabouts of the real types of the early Indian botanists like Roxburgh, Hamilton, Koenig, Rottler and others? Do the Kew botanists claim infallibility for their identifications? Can Chatterjee claim perfection for his work? In 1890, Sir George King wrote to the Government of Bengal "that after having mounted and poisoned, the specimens have to be arranged according to natural families and finally referred to their genera and species. This is botanical work and it can be done only by a skilled botanist. Moreover it can be done quickly and accurately only by a botanist of experience. *It takes many years* to acquire such experience when a flora so varied and extensive as that of India has to be dealt with comprising as it does more than 14,000 species of flowering plants." With his limited knowledge and immature experience in Herbarium work, it was not prudent for Chatterjee to have passed wholesale condemnation of the authenticity of the collections of Indian herbaria in general and of Sibpur in particular. I can also certify to the correct nomenclature of the Coimbatore herbarium collections, over which I was in charge for a number of years, because the entire collection of Coimbatore were carefully studied by Gamble and Fischer for the 'Madras Flora', they published.

V. NARAYANASWAMI

Royal Botanic Garden,
Sibpur, 13-8-1947.

[1] Chatterjee, D., SCIENCE AND CULTURE, *12*, 414-418, 1947.

II

Narayanaswami's letter is the result of an analysis which he has carried out, of apparently two sentences in my article on Kew Gardens. If Mr Narayanswami takes ordinary simple words and by manipulation in his own mind construes from them an attack upon the Calcutta Herbarium, nobody can prevent him. But suppose Mr Narayanaswami is wrong; suppose that there is nothing sinister in the sentences; that the meaning is as plain as it is meant to be—what then? Why then, it means that Mr Narayanaswami's letter need never have been written and was the outcome of what he considered to be criticism of his own herbarium, and therefore prejudiced. We can pass over slighting references to Kew botanists (incidentally most of those distinguished men whose names are listed have worked at Kew) and to myself and will merely point out that the science of taxonomy does not stand still and it is more than likely that the notes of distinguished botanists of fifty years ago, require emendation in the light of discoveries that have taken place in the meantime.

As far as Kew is concerned, it may be stated that this herbarium does not possess all the types and that sheets are frequently sent abroad to be compared with types and serve as the yard-stick for that species when so authenticated. When all the great herbaria of the world do what I suggested India should also do, Mr Narayanaswami objects—why?*†

D. CHATTERJEE

The Herbarium,
Royal Botanic Gardens,
Kew, England.
.-1947.

* Interested readers are requested to refer to my articles on the Botanical Survey of India (*Nature*, **160**, 587, 1947) and on the National Herbarium for India (*Sci. & Cul.*—in press). They might also remember that in the article on Kew Gardens (*l.c.* 418) I stated "Kew has maintained a close and cordial relation with India since its beginning. This was mainly done through the Botanic Garden at Sibpur etc." *D.C.*

† The correspondence is closed. Ed. *Sci. & Cul.*

COMPLEMENTARY SERIES AND CONJUGATE FRAGMENTS IN URANIUM FISSION

As a result of rapid progress in the study of nuclear fission, 170 active isotopes of 35 elements from $_{30}$Zn to $_{64}$Gd have now been discovered. The mass numbers of the isotopes range from 72 to 158 and indicate the presence of 87 radio-active chains. A chain is provisionally termed light when its mass number is either equal to or below 117 and heavy when its mass number lies above 117. We have 46 radio-active chains in the light group and 41 chains in the heavy group.

The observation so far recorded from ionization and cloud chamber studies are such that we are confronted with a mass phenomenon involving huge number of different fission processes and as such we cannot trace the individual complementary chains and after that cannot locate conjugate fragments which are responsible for the complementary chains in question.

An attempt has been made to sort out the complementary series from an analytical study of the yield mass curve,[1] (Fig. 1) and to sort out the conjugate fragments due to which the complementary series in question have been formed.

From the nature of the yield-mass curve it has been pointed out that corresponding to a light point there is a heavy point with almost identical yield which may be taken to be the same within experimental error. Mass numbers 84 and 150 may serve as a typical example. We can trace such conjugate numbers from 76 to 117 on the light side and corresponding ones from 158 to 117 on the heavy side. The conclusion has been arrived at that from the two extreme ends (at 76 and 158) as we pass from mass number to mass number each pair represents a com-

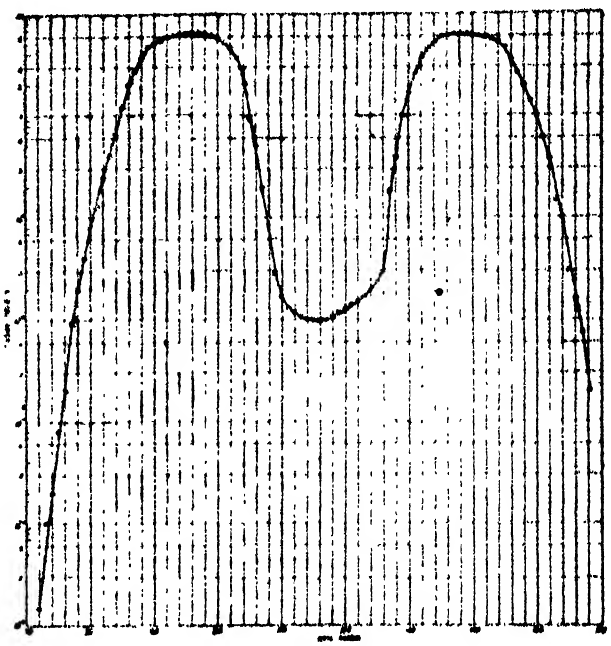


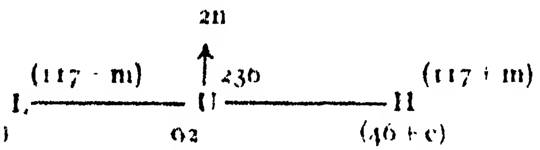
FIG. 1

plementary series till the two curves meet at a point due to mass number 117 which represents a case of symmetrical fission.

From the complementary series thus identified, conjugate fragments which are responsible for a pair of chains in question have been sorted out.

In consideration of practical evidences, the idea that a complementary series is solely due to the β-decays of a single pair of initial fragments has been shown to be erroneous. It has been argued that each and every nucleus in a pair of complementary series is of primary origin but the yield in each case has been enhanced due to the β-decay of the predecessors. Different probable modes of fission in between the stable members of each pairs of complementary series, with an assumption that the sum of the charges of the two conjugate fragments in each case is 92 has been considered. It has been argued that fission probabilities of all processes of primary formation in pair of complementary series is not equal. It has been concluded that in a complementary series the contribution by that particular mode of fission to the yield is greatest, which has approximately identical values for the mass/charge ratios of the two conjugate fragments and the fission frequency of the conjugate fragments in the complementary series in question get less and less and merge beyond the limit of experimental observations as the ratio values diverge from this equivalent point.

On this basis a list of equations denoting maximum yield due to a single mode of fissions in complementary series has been introduced. It has been found that a symmetrical fission is symmetrical both as regards mass and charge as far as maximum yield by one mode of fission is concerned. The following symbolical representation will explain the general feature of complementary series.



where (1) (117 - m) and (117 + m) stand for mass numbers for the light and heavy series respectively, where as far as observation goes, m varies from 0 to 41.

(2) (46 - e) and (46 + e) represent charge numbers of the conjugate fragments where the value of e varies from 0 to 10.

The following example will explain how from the complementary series conjugate fragments are sorted out and most probable conjugate fission fragments have been found out.

Due to identical position in the curve, the series with mass numbers 76 is complementary to that with mass number 158. Possible nuclei in between the stable members of the series are pictured below. (Fig. 2).

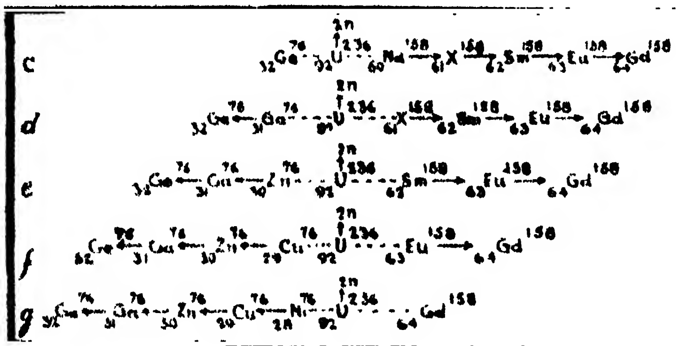


FIG. 2

The mass/charge ratio values of the conjugate fragments with addition of one unit of mass in each case are tabulated below.

Mass numbers 76 - 158.

Eq. No.	Light A/Z	Values	Heavy A'/Z'	Values
(a)	77/34	2·265	159/58	2·742
(b)	77/33	2·333	159/59	2·695
(c)	77/32	2·406	159/60	2·650
(d)	77/31	2·484	159/61	2·607
(e)	77/30	2·566	159/62	2·564
(f)	77/29	2·656	159/63	2·524
(g)	77/28	2·750	159/64	2·484
(h)	77/27	2·852	159/65	2·446

From the values it seems that equation (e) has the maximum yield due to a single mode of fission, that is 30 (Zn) and 62 (Sm) are the most probable charge numbers here.

On this basis the most probable conjugate charge numbers and other probable charge numbers in each complementary series have been found out and predictions as regards the missing nuclei in fission have been made. The details are ready for publication.

The author is indebted to Prof. M. N. Saha, F.R.S., for his interest and encouragement in the work and to Krishnarpan Charity Trust Fund for the endowment of a fellowship.

B. C. PURKAYASTHA

Nuclear Physics Laboratory,
University College of Science and Technology,
92, Upper Circular Road,
Calcutta, 19-8-1947.

[1] *Chem. Eng. News*, 25, 1509, 1947.

ON THE MOISTURE CONTENT OF QUININE SULPHATE

I

Mukherjee[1] has remarked that the determination of moisture content in Quinine Sulphate is of secondary importance and in his opinion the most rational procedure would be to express the quantity of Quinine Sulphate in terms of actual alkaloid content based on analysis. In business transaction, the valuation of Quinine Sulphate should be based on actual alkaloid content provided the sample is pure. But the alkaloid content by itself cannot be taken as a sure criterion of purity of the stuff. In finding out the purity, analysis of each constituent (*viz.*, Quinine Sulphate dihydrate and moisture determined by drying the same in an oven at 80°C) is essential. The moisture content of Quinine Sulphate is uncertain. If only the alkaloid content is determined, any harmful adulterant present may escape detection. In a pure sample the percentage of Quinine Sulphate, $2H^2O$ plus the percentage of moisture (determined by drying at 80°C for half an hour) must make up 100 per cent within the limits of experimental error. The determination of moisture content is, therefore, as important as the determination of alkaloid content to preclude the possibility of any foreign matter remaining unchecked in the sample. Das and Sen Gupta's[2] rapid routine method for estimation of

moisture in Quinine Sulphate is based on the above principle.

B. K. DAS

Analytical Laboratory,
Standard Pharmaceutical Works Ltd.,
Calcutta, 9-9-1947.

S. Mukherjee, SCIENCE AND CULTURE, *13*, 74, 1947.
B. K. Das and S. B. Sen Gupta, SCIENCE AND CULTURE, *12*, 555, 1947.

II

Das[1] refers to Das and Sen Gupta's[2] "rapid routine method for the estimation of moisture in Quinine Sulphate" and appears to suggest that this would suffice for detecting any "harmful adulterants" present in the quinine. My obsversations[3] referred to the quantitative evaluation of quinine in its salts. For the detection of adulterants, one would have to carry out the appropriate purity tests and a "rapid" empirical method as suggested by Das and Sen Gupta would hardly be a safe guide.

S. MUKHERJEE

Bengal Immunity Research Laboratory,
Calcutta, 28-10-1947.

[1] B. K. Das, SCIENCE AND CULTURE, this issue.
[2] B. K. Das and S. B. Sen Gupta, *ibid.*, *12*, 555, 1947.
[3] S. Mukherjee, *ibid.*, *13*, 74, 1947.

ON THE TRYPANOCIDAL ACTIVITY OF ARSENICALS

Both the pentavalent and the trivalent arsenicals are now being tried clinically for combating trypanocidal infection. It is generally believed that these compounds are active in arsenoxide forms and are presumed to be converted to arsenoxides before exerting trypanocidal action. But, in practice the pentavalent compounds (Tryparsamide, Orsanine, *etc.*) are being found to be more effifficacious from therapeutic point of view.

The trypanosomes are bodies containing thiol group and the importance of —SH compounds in relation to the trypanocidal action of arsenicals was first suggested by Ehrlich[1] and established experimentally by Voegtlin, Dyer and Leonard.[2] Voegtlin[3] supposes that arsenicals are converted in the body to arsenoxide derivatives, than combine with the thiol group of trypanosomes and inhibit their growth in the system. This hypothesis is supported by the fact that injection of compounds containing a —SH group simultaneously with a trypanocidal drug lowers the rate of disappearance of trypanosomes from the infected animal. But the body system also contains sulphydryl groups and as such the arsenoxide derivative might also combine with these bodies. Thus, there may arise a competition in the affinity of the —ASO derivative towards trypanosomes and also bodies like glutathione. If, from this sphere some quantity of —SH bodies like glutathione can be removed for the time being, the —ASO derivative is expected to combine with the —SH group of trypanosomes to a greater extent and thus the elimination of trypanosomes may be more facilitated.

Now, when a pentavalent arsenical is introduced in the system, it is reduced to —ASO derivative by —SH bodies like glutathione, with the result that for the time being some quantity of —SH bodies like glutathione will be removed from the sphere of activity and the —ASO derivative, thus formed, will have less quantity of —SH body like glutathione to compete for combination than in the case where the —ASO derivative is introduced as such. It may, therefore, be expected that a pentavalent arsenical should possess greater trypanocidal activity than the corresponding trivalent —ASO derivative in the system. Recent findings of Friedheim[4] tend to establish that arsenic acid derivatives have better therapeutic indexes than the corresponding arsenoxides in the system.

T. N. GHOSH

Bengal Immunity Research Laboratory,
Calcutta,
26-9-1947.

[1] *Ber.*, *42*, 17, 1909.
[2] *U. S. Pub. Health Rep.*, *38*, 1882, 1923.
[3] *Physiol. Rev.*, *5*, 63, 1925.
[4] *J. Amer. Chem. Soc.*, *66*, 1775, 1944

SYNTHETICAL EXPERIMENTS IN THE ALICYCLIC SYSTEMS, PART II

IN part I[1] of this series, an attempt was made to find out a general method for the synthesis of 12-keto-steroids. In the following lines are described in short, three different methods which have been successfully developed for the synthesis of the tricyclic systems comprising B, C and D rings and the C_{18}-methyl group and the 12-keto group. These methods are capable of extension in order to realize the final objective, *i.e.*, the characteristic tetracyclic system with the iso-octyl group and the two angular methyl groups.

The first method starts from ethyl cyclohexan-1-acetate-2-cyanacetate which condenses with γ-iodo-butyric ester to give the cyano-ester (205-210°/2 mm.). This on hydrolysis and esterification gives the desired tricarboxylic ester (195-200°/4 mm.). This is again prepared from the condensation product (176°/3 mm.) of ethyl 2-bromo-cyclohexylidene acetate with ethyl cyclopentanone carboxylate which on reduction and fission with sodium ethoxide gives the same tricarboxylic ester. This on Dieckmann's condensation and subsequent hydrolysis and esterification gives the keto-ester (I, 145-150°/3 mm. semicarbazone, m.p. 149-50°). This on successive treatment with methyl magnesium iodide, dehydration and hydrolysis gives the desired unsaturated acid (165°/2 mm.). The hydroxy-ester, on distillation passes into a neutral substance, the properties of which closely resemble those of a lactone. The acid-chloride of the above undergoes ring closure in presence of stannic chloride and the chloroketone on heating with dimethylaniline gives the unsaturated tricyclic ketone (128-130°/3 mm.) in a poor yield. In presence of potassium, the iso-octyl side chain can be introduced at the methylene group α- to the keto-group of the above keto ester (I).

Ethyl 2-bromocyclohexylidene acetate reacts with ethyl 2-methyl-cyclopentanone-2-carboxylate in presence of magnesium to give the hydroxy ester (165°/2 mm.) which on catalytic reduction is treated with thionyl chloride and pyridine and hydrolyzed with alkali. On esterification, the desired dimethyl ester (148°/3 mm.) is obtained, along with a considerable low boiling neutral portions separable into two fractions (95-98°/2 mm. and 125-130°/3 mm.). The dimethyl ester after catalytic reduction undergoes Dieckmann's condensation and on hydrolysis the tricyclic ketone is obtained (135°/5 mm.).

The third method consists of the following steps. Ethyl 2-methylcyclopentanone-2-carboxylate on bromination and on heating with quinoline gives the unsaturated keto-ester. Reduction with aluminium isopropoxide of the above gives the unsaturated alcohol (124°/9 mm.) which gives the bromo-unsaturated ester on treatment with phosphorus tribromide. This condenses with cyclohexanone to give ethyl 2-(2'-ketocyclohexan)-Δ^1-cyclopenten-1-methyl-1-carboxylate (130-35°/2 mm.). This on reduction and hydrolysis gives the expected keto-acid. This keto acid has again been prepared by condensing δ-bromo-valeric ester with ethyl 1-methylcyclopentan-1-carboxylate-2-cyanacetate. The condensation product (212°/5 mm.) on hydrolysis and esterification gives the tribasic ester (190-95°/3 mm.) from which, on Dieckmann's condensation and hydrolysis gives this acid. The acid-chloride of this keto-acid condenses with magnesio-malonic ester. On hydrolysis it gives the methyl ketone (133°/3 mm.) and this diketone on dehydration is expected to give the unsaturated tricyclic ketone (130-35°/3 mm.) isomer with the one described before, with respect to the double bond.

The condensation product from cyclohexanone and unsaturated bromo-ester on hydrolysis gives the unsaturated keto-acid from which in an identical way the methyl ketone (140-45°/5 mm.) is obtained. The diketone on dehydration is expected to give the doubly unsaturated tricyclic ketone. On reduction of the double bond adjacent to the carbonyl group and of the carbonyl group according to Clemmensen, a tricyclic unsaturated hydrocarbon is available. It is possible to introduce at the methylene group (so called C_{17}-position of the steroids) in the cyclopentene ring a bromine atom with the help of N-bromo succinimide. These methods are being extended with α-methyldecalone.

My grateful thanks are due to the National Institute of Sciences of India for an I.C.I. Research Fellowship in Chemistry. The details will be published in the *proceedings* of the National Institute of Sciences of India.

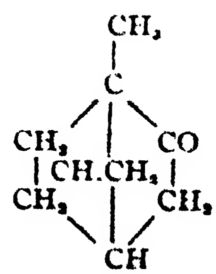
PHANINDRA CHANDRA DUTTA

I.C.I. Fellow's Laboratory,
University College of Science and Technology,
Calcutta, 14-10-1947.

[1] SCIENCE AND CULTURE, 9, 505, 1943-44.

A NEW SYNTHESIS OF SANTENONE

SANTENONE (I) which can be isolated from East Indian sandalwood oil has formed the subject of numerous investigations.[1] Its formation from teresantalic acid and santene obviously involves deep seated molecular rearrangement. Upon oxidation santenone furnishes santenic acid, which has been prepared synthetically and the synthetic acid has been converted into homosantenic acid and santenone by an adaptation of the well-known Haller-Komppa method[2].



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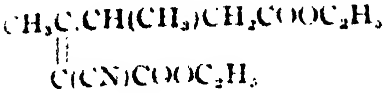

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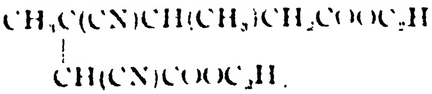

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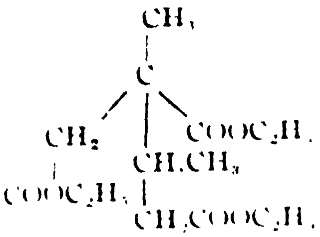

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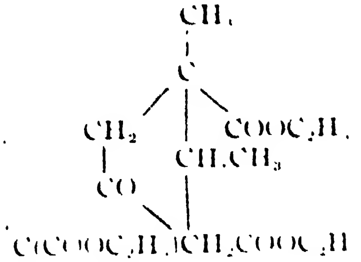

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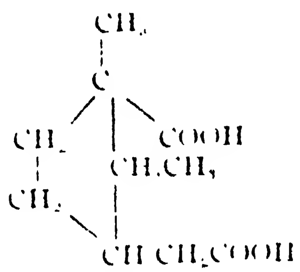


(VI)

A simpler synthesis of santenone is now described starting with ethyl-β-methyl laevulate. This was condensed with ethylcyanoacetate, using Cope-technique[3] to give ethyl βγ-dimethyl-α-cyano-Δ^{α}-butene-αδ-dicarboxylate (II) b.p. 162°/4 mm. The unsaturated ester readily entered into consideration with the elements of hydrogencyanide[4] with the formation of *ethyl-α-β-dicyano-βγ-dimethylbutane-αδ-dicarboxylate* (III). b.p. 182°/4 mm. which on hydrolysis with hydrochloric acid in the usual way yielded a liquid acid which would not solidify. The corresponding *triethyl ester* (IV) b.p. 154°/4 mm., prepared according to the alcohol-vapour method on sodium-condensation followed by the action of ethyl bromacetate on the resulting sodio-salt afforded *ethyl 3:4-dimethyl cyclopentan-1-one-2:4-dicarboxylate-2-acetate* (V) b.p 185°/4 mm., unaccompanied by any appreciable quantities of isomeric esters[5]. The latter on hydrolysis with hydrochloric acid gave a liquid keto-acid which on reduction with amalgamated zinc and hydrochloric acid yielded *homosantenic acid* (VI) m.p. 165°. The acid was converted into the corresponding lead salt, in the usual way, and the latter on distillation at the ordinary pressure gave *santenone* as an oil, the identity of which was established by the preparation of the characteristic semicarbazone m.p. 220° and by a direct comparison with an authentic specimen. The regenerated ketone had m.p. 48-49°.

My sincere thanks are due to Prof. J. C. Bardhan, for his kind guidance and interest throughout this investigation and for giving me facilities to work in his laboratories; and to Principal, Bethune College, Calcutta, for permission to work in my spare time in Prof. Bardhan's laboratories.

(MISS) DEBI MUKHERJI

Khaira Professor's Laboratory,
University College of Science and Technology,
92, Upper Circular Road,
Calcutta, 30-10-1947.

[1] Semmler and Bartelt, *Ber.*, **40**, 4467, 1907, Schimmel's Report, 1910, p 98. Aschan, *Ofvers Finska, Vet-Soc.*, **53** (A), No. 8, p 17, 1910.

[2] Enkvist, *J. pr. chem.*, **137**, 261, 1933 (II), Kompa, *Ber.*, **65** (B), 1708, 1932; Diels and Alder, *Annalen*, **486**, 208, 1931

[3] Cope and co-workers, *J. Am. Chem. Soc.*, p. 3455, 1941, and other publications.

[4] Lapworth and McRae, *J. Chem. Soc.*, p 2745, 1922.

Chakravarti, *J. Ind. Chem. Soc.*, **10**, 173, 1943, and subsequent papers.

SYNTHESIS OF FUSED RINGS

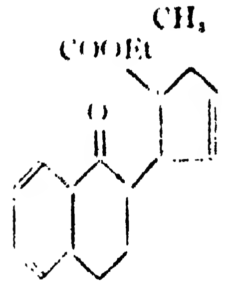
FOR the synthesis of the tetracyclic systems characteristic of the Steriods and related bodies, the following methods have been explored:

As starting materials, *cyclo*pentane derivatives have been utilised and the other rings have been gradually introduced. This method has a decided advantage of controlling the steriochemistry of C and D rings.

The acid chloride of trans-1-methyl-1-carbo-ethoxy *cyclo*pentane-2-carboxylic acid is allowed to react with diazomethane which on treatment with hydrobromic acid gives the bromo ketone (130-35/6 mm.). This reacts with sodio malonic ester in benzene solution to give the desired product (175-80/3 mm.). This on hydrolysis and Clemmensen reduction and esterification gives the diester (140-42/5 mm.).

Ethyl 2-methyl*cyclo*pentanon-2-carboxylate on bromination and treatment with quinoline gives the unsaturated keto-ester. On reduction with Aluminium isopropoxylate gives the corresponding unsaturated alcohol (115-20/8 mm.), which is converted into

bromide with PBr_3. This is condensed with tetralone in presence of potassium to give



From this, the C-ring can be built up in the usual way through methyl diketone and subsequent dehydration.

The special interest that lies in having the unsaturation in the *cyclo*pentane ring will give an opportunity to introduce a suitable substituent in the so called C-17 position of the steriods. The other function of the double bond is to activate Br atom in the condensation described above.

Preliminary experiments have shown the Br atom in the bromo-*cyclo*pentane ester occupies a trans position with respect to the carbethoxy group, consequently the trans-locking of the B and C rings can be conveniently carried out by this method.

The author's sincerest thanks are due to Dr N. K. Sen, D.Sc., for his keen interest in this work, and to Dr P. C. Datta, D.Sc., for suggesting the problem.

A. Q. Ahmed Ullah Choudhury

Chemical Laboratory,
Presidency College,
Calcutta, 15-1-47.

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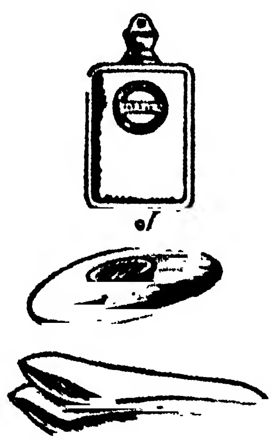

SCIENCE AND CULTURE

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Vol. 13, No. 7] [JANUARY, 1948

CONTENTS

SCIENCE AND CULTURE

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INDIGENOUS SYSTEM OF MEDICINE

THAT the ancient Hindus made considerable progress in the science of medicine, is fully acknowledged by savants who have studied both the Western and Eastern systems, ancient and modern. It was Dr T. A. Wise, who in 1845 for the first time, placed the merits of the Hindu system of medicine before the western world. He gave a pretty full and accurate account of the anatomy, surgery and pathology of the Hindus.

The efficacy of medicines is best proved by the cures they effect and the large number of *ayurvedic* and *unani* physicians practising in competition with allopathic, is a standing testimony to the value of indigenous drugs, administered according to the directions left behind by the sages of old. The knowledge that lay hid in ancient Sanskrit works was placed within the reach of all searchers after truth in an elaborate manner by the late Dr Uday Chand Dutt, who in 1870 published a treatise entitled "The Materia Medica of the Hindus", with the object of not only presenting the history of drugs, but also as basis for further researches on indigenous medicines.

Interest in this subject was later revived at the Medical Congress held in Calcutta in 1894 and a Drugs Committee was appointed with the late Dr Kanai Lall Dey as Joint President. The Government of India also appointed a Commission with the object of considering "the desirability of extending the use of indigenous drugs of India".

As a result, the study of the indigenous materia medica, according to modern scientific lines, was first started in India at the School of Tropical Medicine, Calcutta (Chopra School) and at the Haffkine Institute, Bombay (Caius, Mhaskar and others) in the second decade of this century. The problem was approached from several standpoints: (1) Investigation of the possibilities of utilization of pharmacopœial and allied drugs growing in India, in place of the official ones mentioned in the "British Pharmacopœia". (2) Testing of specifics for various diseases. (3) Search for new active principles, specially drugs of alkaloidal character, glucosides, tannins, etc. (4) New sources of therapeutic agents of proven value.

A survey of the work so far recorded at Calcutta and Bombay indicate that no outstanding result has yet emerged, to place indigenous drug research in the scientific map of the world. This should not be disappointing because the drugs investigated so far are only 60 in number whereas the indigenous system of medicine provides over 2000. As a result of these investigations on "Indian Pharmacopœia", as a supplement to "the British Pharmacopœia, 1932", containing all indigenous drugs of value, properly standardized for uses on an extensive scale by modern physicians, side by side with up-to-date chemotherapeutic and synthetic remedies of the Western system of medicine, has now been published by the Government of India (1946).

What we really need is a "Scientific Pharmacopœia", irrespective of whether it belongs to *Ayurvedic*, *Yunani* or allopathic systems. This would automatically remove the barrier now existing between *Yunani-Tibbi* medicine and allopathic medicines. This could only be achieved by joint efforts of the learned exponents of all the indigenous systems of medicine in India, and by more intensive indigenous drug research on modern scientific lines.

The "Report of the Health Survey and Development Committee, 1946" (generally known as 'Bhore Committee'), briefly referred to position which indigenous systems of medical treatment should occupy in any planned organization of medical relief and public health in the country. Three of the members made a definite recommendation suggesting the free utilization of the services of persons trained in the indigenous systems for promoting public health and

medical relief in India. The report rightly turned down the suggestion with the remark, "No system of medical treatment, which is static in conception and practice and does not keep pace with the discoveries and researches of scientific workers the world over, can hope to give the best available ministration to those who seek its aid".

The Central Government, therefore, set up an inquiry committee early in 1947 under the chairmanship of Col. Sir Ram Nath Chopra, to consider and recommend steps to improve facilities for research and training in indigenous systems of medicine and generally to increase their usefulness to the public. The Committee consisted of members representing the *Ayurvedic*, *Yunani* and the Western systems of medicine.

The different Provincial Governments are also engaged in collating facts for the revival of the indigenous system of medicine and treatment. The Committee on the Indigenous System of Medicine, Madras, is of the opinion that (1) *As a science* -the Indian systems of medicine are undoubtedly scientific, their general principles and theories (both in subject of preliminary scientific study like physics and physiology, as also in the subjects of Medical Science proper, like pathology, medicine, and so on) are quite rational and scientific. (We are afraid that this opinion will not be accepted by scientific men). (2) *As an art* as practised at present, Indian systems are not self sufficient If divided broadly into two sections, *viz.*, medicine and surgery, the Indian systems are, generally speaking, self-sufficient and efficient in medicine while in surgery they are not. (We again express our disagreement with the view).

Of the indigenous systems of medicine, *Ayurveda* occupies the first and the Committee set up by the Government of India will, therefore have mainly to report on the revival of the *Ayurveda* system, along modern scientific lines. The *Ayurvedic* system had lost State support for centuries and whatever advancement it has made in recent times has been due to the sporadic efforts of a few individual scholars, which is not much.

The Ayurvedic treatises date back to 1400 B.C. to 400 A.D. but the system as it is practised today is not representative of the older systems. Much later expiricism and superstition in addition to the older ones have been absorbed into the original core of ancient systems during the lapse of centuries.

The history of Ayurvedic literature may be divided into three epochs: --

1. The first period of study and investigation as embodied in the four or five books available at present up to 1200 A.D.

2. The second period, in which, the knowledge so acquired became partly lost, and submerged due to the collapse of the indigenous States, on account of foreign invasions (1200—1800 A.D.).

3. The British period in which there were compilation, revision and commentations, and uncritical laudations by interested parties.

Ayurvedic systems have lost all other departments of medicine except Materia Medica and Medicine.

A system which has remained stagnant and static for well nigh 1500 years is bound to get mixed up with many things of questionable value and doubtful utility There is no harm in recognizing this and devising ways and means in revitalizing indigenous systems of medicine, taking full advantage of the modern developments in physico-chemical and biological sciences Only by such means any progress can be achieved

Time has now arrived for ascertaining the merits and utility of the indigenous systems in the field of preventive and curative medicine in the light of the latest available knowledge and information of medical and allied sciences.

It has been held that science in medicine, as in every other sphere is one and undivided and as there is no indigenous system of Physics, Chemistry or Astronomy nor an English, German or American systems of these, so it stands to reason that there are not so many different systems of medicine.

From the empirical knowledge of a crude drug to its use in rational scientific medicine, is a long way and must pass through (1) Botanical identification, (2) Chemical examination, (3) Pharmacological and toxicological assay and (4) Clinical trials. All stages through which modern scientific investigation should proceed are time consuming and require a 'team work' of several groups of scientists, each experts in their own fields of specialization. No haphazard methods of approach by individuals or even single institution are likely to achieve any tangible result.

A vast field for research and investigation in the indigenous materia medica lie before us. A good way of approaching the problem of indigenous drug research is through the setting up of a 'Central Institute' for drug investigations in India. The co-operation and collaboration of the learned exponents of the *Ayurvedic* and *Yunani-Tibbi* systems should be sought to initiate newer lines of investigation'

For such a project, funds would be needed and the State should come forward to finance the scheme.

The Committee appointed by the Central Government has been asked to consider the question of the rehabilitation of Indian systems of medicines and their recommendations for restoring the indigenous systems to its old and pristine glory as has been

given out in the papers, is not only chauvinistic but opposed to the spirit of science and free enquiry.

The tendency to separatism in science must go. Separate institutions for the modern scientific and the *Ayurvedic* and *Yunani* systems would mean waste of men, materials and money and at a time when the country must produce 1,85,000 medical men during the next 25 years according to the estimate made by the Bhore Committee.

"The Drugs Act, 1940", enforced recently, has exempted operation of the Act, to the drugs used in the indigenous systems of medicine. This is so because of the absence of recognized standards with regard to them. But control over these drugs is equally necessary if the proposed legislation is to be a success.

Standardization of drugs is imperative not only from the national but also from international point of view.

The medical relief to be provided for the people of free India must not only be economical and popularly acceptable but also based on rational and scientific lines. Anything which is valuable in any of the systems has to be pooled and placed at the service of suffering humanity. India can ill afford to run three different systems of medicine, running side by side, each having its own practitioners, hospitals, sanatoria, laboratories, trained staff, etc.

We have to evolve a system of medicine and medical relief based on rational lines capable of proof and verification.

Col. Sir Ram Nath Chopra, who has long devoted himself to the subject of indigenous drug research, and who is President of the Thirtyfifth Session of the Indian Science Congress at Patna, has addressed on the "Rationalization of Medicines in India", which is printed elsewhere in this issue, and we draw the attention of our readers to his address.

CHEMISTRY AND COSMOLOGY IN ANCIENT INDIA

PRIYADA RANJAN RAY

UNIVERSITY COLLEGE OF SCIENCE AND TECHNOLOGY, CALCUTTA

THAT there have been three stages in the development of human knowledge regarding the phenomena of nature can be easily recognized from a study of the history of human civilization. This has been expressed with particular emphasis in the form of a hypothesis by Auguste Comte[1] in 1822, which is sometimes termed as "the law of the three states", or *loi des trois états*. These three stages or epochs have been distinguished by him as the theological or fictitious, the metaphysical or abstract, and the positive or scientific. In the first stage man attempted to explain the natural phenomena by ascribing them to the action of invisible supernatural agents or spirits dwelling in land, water and air ; in the second stage with the development of his reasoning faculty he gave himself up more or less to metaphysical speculation and built up philosophical theories to account for the working of nature ; the third stage represents the positive or scientific era in which man has succeeded in discovering the laws of nature by experimentation and accurate observation of facts. These three stages cannot, however, be regarded as absolutely exclusive since they often overlap and merge into one another. This is nowhere better illustrated than in the evolution of chemical knowledge, particularly in ancient India.

Chemistry in ancient India was intimately associated with religious practices and followed the course of the latter in its development. In fact, at no time was it free from theological tinge or urge. It was a usual practice for the early workers and writers, while discussing theories or describing processes of chemistry, to ascribe the origin thereof to their favourite gods and goddesses, or to start with a prayer to the presiding deity of chemistry. Each element and phenomenon of nature, as well as the properties of each substance, were associated or identified with their respective divinities responsible for their manifestation. The presentation of subject-matter in many old writings and works has often been made in the shape of a dialogue between god Siva or Hara[2] and his consort Parvati or Gouri. This is particularly noticeable in the writings of the Tantric Period and even in many medical compilations made so late as 1500-1600 A.D. during the Mogul rule. Where the authors of such writings or compilations are Buddhist monks, we meet with the name of a Buddha, a Tathagata or an Avalokiteswara being involved as the revealer of all knowledge. Though primarily bound with religious rites showing a royal road to salvation, chemistry in ancient India, more so than in any other land, was evolved chiefly

as a handmaid of medicine and later on of alchemy during the period of Tantric cult.

P. C. Ray in his well-known History of Hindu Chemistry[1] has shown that the evolution of chemistry in ancient and mediaeval India can be conveniently divided into four successive periods. These are distinguished as the Ayurvedic Period, the Transitional Period, the Tantric Period and the Iatro-Chemical Period. But no sharp line of demarcation can be drawn between them as they often insensibly merge into one another. But this does not take into account the development of chemical knowledge, dealing particularly with metallurgy and metal workings, in India of very distant age before the advent of Aryans. This is revealed by the excavations at Mohenjo-daro in Sind and at Harappa in the Punjab, which furnish evidences of the existence of a pre-Aryan civilization round about the Indus valley as early as 3000-4000 B.C.

The Ayurvedic period may be said to have commenced from the pre-Buddhistic era and ended at or about 800 A.D. Of the four Vedas, the sacred scriptures of the ancient Hindus, the Atharva-veda is the last and the latest. The latter is believed to have given birth to Ayurveda or the Science of Life, which is thus regarded by many authorities as a subsidiary branch of the Atharvan and, as such, a revealed production like the Vedas themselves. The Atharva-veda devotes itself mainly to sorcery, witchcraft, demonology, magic, alchemy and cure of diseases by means of charms, incantations and the use of various herbs. Hymns serving as invocations to pearls, gold and lead, believed to show the way to long life and easy salvation, are found in it. For this reason the Atharva-veda is not regarded with as much canonical sanctity as the other three Vedas, *viz.* the Rig, the Sama, and the Yajus; and even its authority as one of the Vedas has been questioned by some. But in Rig-veda too there are mentions of the medicinal properties of many plants and particularly of the exhilarating effect of the fermented juice of the Soma plant. The Soma-juice has been described there as *amrita*, corresponding to the Greek *ambrosia*, a draught which made the gods immortal. The age of the Vedas has been fixed by those, who are competent to judge, at or about 2000-2500 B.C. The Ayurvedic period may, therefore, be said to commence from the Vedic time. The two earliest and most renowned treatises of the period, Charaka and Susruta, by sages of the same name, constitute a methodical and rational presentation of the Hindu system of medicine and surgery, and seem to be repositories of many chemical information of the time. These treatises subsequently came to be known as Charaka-samhita and Susruta-samhita as they passed through repeated recensions by later and more advanced workers. Judging from many-sided evidences the time of their composition may be assigned to the pre-Buddhistic era (600-500 B.C.), nearly a century or more before the birth of Hippocrates (400 B.C.), the originator of medical science in Greece. Previous to Charaka there existed also other standard works or Samhitas, though less systematized, by sages like Agnivesa, Bhela, Jatukarna, Parasara, Harita and Ksharapani. Charaka himself based his work on that of Agnivesa. Similarly Susruta developed his work upon that of his master Dhanvantari. Surgery forms an important part of Susruta-samhita as medicine constitutes the main theme of Charaka-samhita. The next important medical authority of the period, who is held in as high estimation as Charaka and Susruta, is Vagbhata, the author of Astangahridaya (*lit.* heart or core of the eight limbs or divisions of the Ayurveda). Vagbhata seems to have flourished at a time when the religion of non-violence preached by Gautama Buddha was still predominant in India (600-700 A.D.). References to Buddha and some Buddhistic emblems are found in his work. Vagbhata's work is more or less an abridged compilation based mainly on Charaka and Susruta with some abstracts from the earlier treatises of Bhela and Harita. There is, however, very little in it that might be called original.

A very remarkable achievement of this period relates to the physical and chemical theories of the ancient Indians, embracing the process of entire cosmic evolution and the methodology of science. These have been chiefly expounded in the six systems of Hindu philosophy and also to a certain extent in the Buddhistic and Jaina systems. These systems were possibly evolved during the period dating back from the time of the Upanishads (1000 B.C.) to about third century B.C. We shall deal with these theories hereafter, particularly with reference to chemistry.

The next stage in the evolution of chemistry in ancient India is termed the Transitional Period in consideration of the fact that metals, metallic compounds and mineral products were increasingly introduced in medicine in place of herbs and plants which constituted the principal remedies in the Ayurvedic age. This period may be said to extend from *circa* 800-1100 A.D. Vrinda and Chakrapani are the two noted medical authors of this period who contributed in a great measure to increase the stock of chemical information of the time. Vrinda (800-900 A.D.) is the author of the well-known medical treatise named Siddha Yoga, which is more or less a collection of materials gleaned from the works of earlier writers, and follows closely the order and pathology of the reputed medical work Nidana (etiolgy of diseases) by Madhavakara (700-800 A.D.). Chakrapani (900-1000 A.D.) is the author of the celebrated compilation, Chakradatta, which bears his name. He based his work on that of Vrinda and drew freely from the

writings of Charaka, Susruta and Vagbhata. In these two treatises we find methods for the preparation of many metallic compounds, notably of the sulphides of copper, mercury and silver.

The third stage covering the period *circa* 1000-1300 A.D., named as the Tantric Period, is the alchemical age of early Indian chemistry and represents its most advanced or active stage. For, in ancient India the practice of alchemy was closely associated with the religious rites of the Tantric cult, which flourished mainly during this period though of much earlier origin. Almost all treatises of this period abound in so-called recipes for the conversion of base metals into gold and for medicines that would prolong life. Even the Atharva-veda, as mentioned before, consists of hymns dealing with charms, magic, sorcery, astrology, cure of diseases, as well as means for securing long life and permanent youth. As an illustration, the hymn on the Soma plant, describing the properties of its fermented juice, Soma-rasa, may be here referred to.

"The strength of this *amrita* (nectar or ambrosia) do we give this man to drink. Moreover, I propose a remedy that he may live a hundred years".

Thus we may indeed trace the origin of Indian alchemy even up to the Vedic age.

The Tantric cult came into vogue as a result of gradual adoption by the Aryans of the religious practices of the original inhabitants of the land, the non-Aryans, of which the phallus worship formed a prominent part. For instance, the worship of god Siva, one of the Hindu Trinity, incorporated in course of time much that was non-Aryan in character, and Siva himself came to be represented by the emblem of phallus. By the beginning of the seventh century A.D. with the decline of Buddhism and the revival of Brahmanism this Tantric cult became very much popular and prevalent in India. This new cult is centred round the worship of god Siva and his consort Parvati, and is characterized by an admixture of grotesque, revolting and obscene rites on the one hand and the pursuit of alchemy on the other, with the common purpose of attaining health, wealth and salvation. Buddhism too, in its decline, degenerated into a similar type of Tantric cult. We, therefore, find the names of both Hindu and Buddhist workers as authors of many alchemical treatises of this period. Preparation of metals and metallic products, particularly of mercury and its compounds, constitute a characteristic feature of their work. Though inspired with the idea of discovering the Philosopher's Stone or the Elixir of Life, they made valuable contributions towards the development of chemistry in those days. The chemical knowledge of the Hindus may be said to have reached its culmination during this period with its vast mass of accumulated facts. It gave rise to a school of alchemical and medical workers who were known as adepts in *rasas*, the term *rasa* being applied to metals in general and mercury in particular. In fact, the chemistry of the period was practically identified with the knowledge of *rasa* or the philosophy and science of mercury, as the latter metal, when properly applied, was believed to secure for man his health, wealth and salvation. Hence, the term Rasayana or the Science of Mercury may be regarded as the Sanskrit equivalent for alchemy.

The most conspicuous figure among the Indian alchemists is Nagarjuna, the Buddhist worker, who may be viewed as the father and founder of Indian alchemy. He was also the author of a treatise on metallurgy, Lohashastra, and a prominent figure in the Buddhistic canonical literature as the systematizer of the Madhyamika philosophy. He probably flourished in the 8th century A.D.[1] and composed the famous alchemical treatise, Rasaratnakara.

Mention may here be made of a much earlier alchemist, Patanjali, who probably lived in the second century B.C. and has been quoted by later workers as an authority on Lohashastra or the science of iron. He is better known as the commentator of the famous Sanskrit grammar, Panini, and the author of the Yoga system of philosophy. This furnishes an evidence of the antiquity of Indian alchemy, which, as can be judged from the writings of the famous Arabian author Alberuni, was the source of inspiration for the Arabian alchemists like Geber, Rases, Avicenna, Bubacar and others. In the opinion of many authorities the ideas and practice of alchemy reached Bagdad from India through two different routes; partly by direct translation from Sanskrit and partly through Iran, having originally been translated from Sanskrit into Persian and then from the latter into Arabic.

Of the various alchemical treatises of this period mention may be made of the following:

Rasarnava, which abounds in extracts from Rasaratnakara of Nagarjuna, was probably composed in the 12th century A.D.; Rasahridaya by Govindabhagavat (11th century A.D.); Rasendrachudamani by Somadeva (12th—13th century A.D.); Rasaprakasasudhakara by Yasodhara (13th century A.D.); Rasakalpa, possibly composed in the 13th century A.D. and Rasarajalakshmi by Vishnudeva (14th century A.D.).

In many of these treatises, particularly in Rasendrachudamani of Somadeva there are descriptions of various *Yantras* (apparatuses) for distillation, sublimation, extraction, etc.

In the next period, which has been termed the Iatro-Chemical Period, the vast mass of chemical information gathered in the preceding Tantric Period found many useful applications in medicine as the illusive search for the Philosopher's Stone and the

Elixir of Life ended in inevitable failures, and the fanciful ideas of immortality and immeasurable wealth lost all their charms. The Iatro-Chemical Period in India may be said to have extended from 1300 A.D. to *circa* 1550 A.D. A very notable treatise of this period is Rasaratnasamuchchaya by one pseudo-Vagbhata, which is a very systematic, scientific and comprehensive treatise on materia medica, pharmacy and medicine. It has freely utilized the large mass of chemical information to be found in Rasarnava and Rasaratnakara. The date of its composition is believed to lie between the thirteenth and the fourteenth century A.D. Other notable treatises of this period are:

Rasanakshatramalika by Mathana Simha (*circa* 1350 A.D.), **Rasaratnakara** by Nityanatha, **Rasendra-chintamani** by Ramchandra, Rasasara by Govindacharya—more a chemical than medical treatise compiled probably in the thirteenth century A.D., Sarangadhara-samgraha by Sarangadhara in 1363 A.D., Rasendrasarasamgraha by Gopalakrishna a compilation based on many Tantras, Rasendrakalpadruma by Sriramakrishna Bhatta—also a compilation from previous works, Dhaturatnamala by Devadatta—composed possibly in the fourteenth century A.D.

A few more of important medical treatises which were composed towards the end of the sixteenth century A.D. might be added to the above list. Rasapradipa, a standard work on the Tantric method of treatment in which detailed processes for the preparation of mineral acids by distillation are described; Rasakaumudi by Madhava, and Bhavaprakasa by Bhavamisra are other compilations of this type. Dhatukriya, which means operations with metals, is a notable production of the time; so also is Arkaprakasa, a treatise on the preparation of medicinal essences and tinctures.

Then there followed a dark age in Indian chemistry and for nearly three centuries starting with the decline of Mogul period till the beginning of the twentieth century, the Indian mind remained dormant and sterile so far as the progress of chemistry was concerned. Arts and sciences in early India were largely cultivated by higher classes; but with the increasing rigidity of the caste system in later periods experimental work with hands, and hence the pursuit of chemistry and other practical sciences, came into disrepute and was considered undignified as tending to lower the standard of refined thoughts. The conditions prevailing at the time were, therefore, most uncongenial to the progress of a practical science like chemistry and cannot be better described than in the words of P. C. Rây as given below:[5]

"The arts and sciences being thus relegated to the low castes with the professions made hereditary, and the intellectual portion of the community being thus withdrawn from the active participation therein, the spirit of enquiry gradually died out among a nation naturally prone to speculation and metaphysical subtleties, and India for once bade adieu to experimental and inductive sciences. Her soil was rendered morally unfit for the birth of a Boyle, a Descartes or a Newton, and her very name was all but expunged from the map of the scientific world."

I would like now to confine myself in what follows to a synoptic survey of the Theories of Cosmic Evolution as developed by the ancient Hindus, relating particularly to the constitution and properties of matter.

As stated before, almost all the important scientific theories of the early Indians were developed during the Brahminical and the Buddhistic periods and were embodied in their various systems of philosophies. Though purely speculative in character with little or no experimental verification, being the result of only systematic and logical thoughts, yet they may be said to stand in good comparison with the most recent and advanced scientific ideas of our time, because of the stamp of intellectual perfection and sublime intuition which they bear. The achievement of the ancient Hindus in this respect may be said to represent Comte's second stage, the metaphysical or abstract stage, in the development of human knowledge. It is difficult to fix the dates of the six systems of Hindu philosophies as also their relative chronological positions. Some of them might be composed as early as the Upanishadic period, *i.e. circa* 1000 B.C. Of all the Indian philosophies the Samkhya system by Kapila is possibly the oldest. It has given us a comprehensive picture of cosmogenesis in both its material and metaphysical aspects. The Yoga system by Patanjali also does the same differing somewhat in details. It was, however, Kanada, the founder of the Vaiseshika system, who has presented us with a concrete and clear picture of the ultimate unit of matter, or atom. The atomic theory of Kanada may, therefore, be said to have been formulated much earlier than that of the ancient Greek philosophers, Democritus, Plato and others (470-322 B.C.). According to Greek tradition Thales, Empedocles, Anaxagoras, Democritus and others travelled to oriental countries with a view to study their philosophy. This suggests the possibility of the Greeks having been influenced by the Indian philosophical conceptions through Iran. Colebrooke[6] is also of opinion that the Indians in this instance were rather teachers than learners. Prof. H. H. Wilson[7] too, in his preface to the Samkhya Karika observes "that the Hindus derived any of their philosophical ideas from the Greeks seems very improbable, and if there is any borrowing in the case, the latter were most probably indebted to the former".

The Nyaya system by Gautama, as also the Vaiseshika system of Kanada, have laid down a methodology of science and have elaborated the concepts of mechanics, physics and chemistry. The other systems of philosophy, including those of Buddhists and Jainas, have also made some incidental contributions on the process of cosmic evolution and the constitution of matter.

The Samkhya-Patanjali View of the Process of Cosmic Evolution

The Samkhya theory of cosmogony, which is also upheld by Patanjali in his Yoga system in all essential points, though formulated without any experimentally verified facts, may be viewed as possessing all the characteristic of a scientific hypothesis. For, it is based on the principles of conservation, transformation and dissipation of energy.

According to Samkhya, the universe, as it is manifested to us, is evolved out of an unmanifested cosmic nature termed Prakriti or Avyakta, the ultimate ground. It is defined as an infinite, eternal, ubiquitous, indestructible, undifferentiated, indeterminate continuum which is made up of infinitesimal Reals or Gunas, representing substantive entities. The Gunas are classed under three heads, which represent three different phases or moods of the cosmic nature. These are named: (1) Sattva, the essence responsible for the manifestation of a phenomenon; (2) Rajas, the energy characterized by tendency to do work or overcome resistance; (3) Tamas, the inertia that counteracts the tendency of Rajas to do work and of Sattva to conscious manifestation. Sattva is regarded to serve as the medium for the reflection of intelligence without which there can be no conscious manifestation of a phenomenon. Rajas and Tamas can acquire conscious manifestation only in association with Sattva. Hence, Sattva is regarded as the intelligence stuff, Rajas, the energy stuff, and Tamas, the matter stuff. The three Gunas, thus representing the three different moods of the infinite continuum, Prakriti, exist together in equilibrium or uniform diffusion. It is highly intriguing to note here that Samkhya attributes the character of both quantum (*parichchinnatya*) and continuity or extension (*pariman*) to Rajas the energy stuff. One may compare this to our modern conception of radiant energy. In the beginning the infinite, unmanifested, undifferentiated continuum, Prakriti or Avyakta, was in a state of perfect equipoise with its infinitesimal Reals or Gunas in uniform diffusion. In other words, the different phases or moments of Prakriti were so adjusted that neither was anywhere in preponderance over the others at that time. This represents a standstill or slumbering state of the universe when the process of cosmic evolution with transformation of energy is under arrest. For the evolution to start there must be a disturbance of the equilibrium, which means an irregular distribution of the Gunas or Reals in Prakriti. The process of evolution or creation is then initiated by a disturbance of this equilibrium through the transcendental or magnetic influence exerted on the slumbering Prakriti by Purusha, the Absolute, often designated as the Soul, the Atman, or the Transcendental Self. Purusha is incapable of modification or affection of any kind either as subject or object. An unequal aggregation or collocation of Gunas leading to creative transformation accompanied by evolution of motion (*parispanda*) then starts, overthrowing the original equilibrium in the system. The evolution is defined by Samkhya as the process of differentiation in the integrated whole. It consists in the development of a differentiated state within the undifferentiated, of the determinate within the indeterminate, of the coherent within the incoherent. This proceeds in accordance with a definite law which it cannot violate or overstep. This increasing differentiation proceeds side by side with increasing integration within the evolving whole, whereby the original, incoherent, indeterminate, homogeneous whole evolves into a coherent, determinate, heterogeneous whole. The successive stages in the process of cosmic evolution are thus distinguished by Samkhya:[8]

I. Prakriti—the unmanifested, unknowable, slumbering cosmic nature,—the ultimate ground.

II. Mahat—the knowable empirical universe, cosmic object of experience as stuff of conciousness evolved by differentiation and integration from Prakriti.

III. Ahankara—individuated but still indeterminate stuff from Mahat by differentiation and integration. This bifurcates into two co-ordinate series, the subject experience series and the object experience series.

(*a*) The subject experience series.
Rajasic Ahankara, Empirical Ego, Asmita—individuated, indeterminate mind stuff.

(*b*) The object experience series.
Tamasic Ahankara, Bhutadi—individuated, indeterminate matter stuff, subtile material potencies.

Further differentiation and integration in each series then give:

(*a-i*) Determinate mind stuff—comprising of Manas (mind), five sense stuff of perception and five sense stuff of operation.

(*b-i*) Determinate matter stuff,—Tanmatras—infra-atomic particles of subtile matter, five in kind.

(*b-ii*) Bhuta - atoms and molecules of gross matter, five in kind.

(*b-iii*) Manifested gross matter.

The order of the cosmic evolutionary process is represented in a tabular form below.

Prakriti
or
Avyakta
|
Mahat
|
Ahankara
|

Rajasic Ahankara	Tamasic Ahankara, Bhutadi or super-subtile matter rudiment
|	|
Determinate mind stuff comprising Manas, five sense stuff of perception and five sense stuff of operation	Tanmatras or five classes of subtile matter
	|
	Atoms (*Paramanu*) and molecules (*Anu*) of five Bhutas or gross elements
	|
	Gross matter in general

Samkhya conceives of the cosmic evolution as a twofold process, creative as well as destructive, dissimilative as well as assimilative, katabolic as well as anabolic. As by unequal aggregation of Gunas, which implies their transformation, the creation of organic and inorganic matter results, so there is a constant tendency on the part of the unstable equilibrium produced by unequal aggregation to revert to the original stable equilibrium of Prakriti with the uniform equal diffusion of the Gunas. This suggests a dissipation of the energy-and the mass-stuff.

The totality of the Gunas in the universe remains always constant, taking together the manifested and the unmanifested, *i.e.* the actual and the potential. It is only the changes or differences in their collocation or aggregation which are responsible for the diversity of phenomena and objects. This implies a principle of the conservation of the mass-stuff (Tamas) and energy-stuff (Rajas) as well as of their transformation. The Law of Causation then follows directly as a corollary from this.

The conception of space (*Desa*) and time (*Kala*), and the idea of causality as elaborated by Samkhya, are of a surprisingly advanced character, which can be bodily transferred with little modification to any modern text-book of science. This is, however, not a proper place for discussion on these subjects.

As we are primarily concerned with the theories of matter and its constitution, I would like to confine myself to these, leaving aside the purely metaphysical aspects of the Indian philosophical systems. We have seen that in the Samkhya view the genesis of matter, as an individuated though indeterminate form, may be traced to the Bhutadi or Tamasic Ahankara stage. The Sanskrit term Bhutadi literally means the origin of Bhuta or matter. This stage of matter is a homogeneous stage without the development of any physical or chemical character except that of quantum and extension. On further differentiation and unequal aggregation the next stage of Tanmatras, or infra-atomic particles of subtile matter, appears with the development of physical character like powers of vibration, penetrability, impact, radiation and attraction. These Tanmatras are also charged with the potentials of energies represented by sound, touch, colour, taste and smell. But being infra-atomic particles of subtile matter, their potentials do not assume the same form as in the particles of gross matter, namely in the atoms and molecules. Five classes of Tanmatras can thus be distinguished. (1) Tanmatras possessing potentials of vibratory energy (*parispanda*) or sound stimulus; these constitute the radicle of the Akasa (ether) atom. (2) Tanmatras, possessing the potentials of mechanical pressure in addition to that of vibration, which mean the potential of tactile stimulus, serve to form the radicle of the Vayu (air) atom. (3) Tanmatras, charged with the potentials of radiant energy (heat and light) in addition to those of pressure and vibration, which represent the potential of colour stimulus, constitute the radicle of the Tejas (radiation) atom. (4) Tanmatras, charged with the potential of the taste stimulus representing the potential of the energy of viscous attraction in addition to those of radiation, pressure and vibration, constitute the radicle of the Ap (water) atom. (5) Tanmatras, which possess the potential of the smell stimulus representing the potential of the energy of cohesive attraction in addition to those of vibration, impact, radiation and viscous attraction, serve to form the radicle of the Kshiti (earth) atom. We thus find that from the five Tanmatras or infra-atomic particles of subtile matter, *viz.*, Akasa-tanmatra, Vayu-tanmatra, Tejas-tanmatra, Ap-tanmatra and Kshiti-tanmatra, atoms and molecules of five class of gross matter Akasa (ether), Vayu (air), Tejas (fire), Ap (water) and Kshiti (earth) --are produced.

There is, however, a wide divergence of views regarding the genesis and the structure of Tanmatras, *Paramanus* and *Anus*. According to Samkhya *Anus* (atoms) are composite units made up of Tanmatras (infra-atomic particles) which again are derived from Bhutadi (homogeneous super-subtile matter rudiment) where all perceptible distinctions between matter and energy disappear. The five types of matter should not be confused with five different elementary substances in the usual sense. They are regarded as representing five abstract principles, or rather a classification of substances on the basis of their properties and states of aggregation. For instance, earth, water

and air may be viewed as comprising all the so-called elements and compounds of chemistry. Thus Kshiti typifies all solids, Ap all liquids, and Vayu all gases. In this there is much resemblance with the Greek theory of elements promulgated by Empedocles (500 B.C.). The difference in the properties of the same Bhuta class is attributed by Samkhya to a difference in the grouping of Tanmatras in their atoms or Anus.

The Vedanta System on Cosmic Evolution

The Vedanta system of philosophy by Badrayana gives, however, a slightly different view of the process of cosmic evolution. The Vedanta replaces Prakriti of Samkhya by what it calls Maya, as the substantial cause of the universe. Maya has the power to confer apparent or practical reality on that which does not and cannot possess absolute reality or self-existence. Brahma (Self) alone represents absolute reality, absolute intelligence and absolute bliss. But unlike Prakriti, Maya is not independent of Brahma which corresponds to Purusha of Samkhya. By Vivarta, the process of self-alienation, Brahma originates Maya and from the latter by the same process of alienation eventually the world takes its rise. The self alienation of the Absolute, acting through Maya, first produces the Sukshma Bhuta (subtile matter) of Akasa (ether), which is infinite, ubiquitous, imponderable, inert and all-pervasive in character. From the Sukshma Bhuta of Akasa, other Sukshma Bhutas, classes of subtile matter, then arise in an ascending linear order: Akasa $\longrightarrow$ Vayu $\longrightarrow$ Tejas $\longrightarrow$ Ap $\longrightarrow$ Kshiti. These five Sukshma Bhutas correspond to the five Tanmatras of Samkhya and possess the corresponding characteristic properties and latent energies. From these Sukshma Bhutas, or subtile rudiment of matter, then arise the five Mahabhutas (gross matter) by a process of combination called Panchikaran (quintiplication). As a result of this, each Mahabhuta is compounded up of all the five Sukshma Bhutas as ingredients, in the proportions of four-fifths of the Sukshma Bhuta of its own type and one-fourth of each of the other four Sukshma Bhutas.

The Atomic Theory of Kanada

The properties of matter and the nature of atoms and molecules have been elaborately studied by Kanada, the founder of the Vaiseshika system. The atomic theory of Kanada has many points in common with that of the Greek philosopher Democritus (470-360 B.C.).

Akasa (ether), according to Kanada, has no atomic structure; it is inert and ubiquitous serving only as the substratum of sound which is supposed to travel in the form of waves in the manifesting medium of Vayu (air). Samkhya too conceived of Akasa as the universal, all-pervading medium in which air, light and heat corpuscles, and other atoms, move and float about. Kanada, therefore, recognizes four kinds of atoms, *viz.*, the Kshiti, the Ap, the Tejas and the Vayu atoms, which correspond to the atoms of four gross elementary types of matter, earth, water, fire and air, as taught by the Greek philosophers. Regarding light and heat Kanada makes the remarkable statement that they are only the different forms of one and the same essential entity, Tejas. Kanada attributes to these atoms certain characteristic properties, such as number, quantity, individuality, mass, gravity, fluidity, velocity, elasticity, as well as certain characteristic potentials of sense stimuli like colour, taste, smell or touch. According to him, atoms cannot exist in a free or uncombined state though eternal and indestructible. The qualities of Kshiti are colour, taste, smell and touch; the distinguishing quality is, however, smell. Ap has the qualities of Kshiti excepting smell and with the addition of viscidity; its distinguishing quality is coolness. Tejas has the qualities of Kshiti except smell, taste and gravity; its distinguishing quality is colour and hotness. Vayu has the qualities of Kshiti with the exception of smell, taste and colour; its distinguishing quality is touch.

Combination of Atoms.—One atom unites with another under an inherent impulse to form a binary molecule or a compound of two atoms. The atoms possess an intrinsic vibratory or rotary motion (*parispanda*). Atoms of the same Bhuta uniting in pairs give rise to molecules with homogeneous qualities corresponding to the original qualities of the atoms, provided no chemical change under the action of heat corpuscles takes place. This obviously represents the formation of binary molecules of elementary substances according to our modern conception. The binary molecules then combine among themselves by groups of three, four, five, etc., to produce larger aggregates in obedience to the moral law underlying the creation. The variety of elementary substances is thus originated. Another view of the same school, however, maintains that some atoms may unite in pairs, some in triads, others in tetrads, etc., either directly or by the successive addition of one atom to each preceding aggregate. This leads to the formation of binary, ternary, quarternary, etc., molecules. The variety of substances of the same Bhuta class, say, of the earth substances, is thus the consequence of the difference in their molecular composition and configuration with the development of different specific qualities.

An elementary substance, thus produced by primary combination, may, however, undergo qualitative transformation under the influence of heat cor-

puscles. The process consists of the following changes in order: (1) their decomposition into the original homogeneous atoms, (2) a transformation of the character of the atoms, and (3) the reunion of the transformed atoms into different groups or arrangements with development of new characteristic properties.

Combination may also take place either between atoms of two or more substances belonging to the same Bhuta class or of those of different Bhuta class. A classification on this basis giving the following order of compounds has been made.

(A) Mono-Bhautic Compounds—these are the simplest; *i.e.*, compounds formed by the union of homogeneous atoms of different substances which are isomeric modes of the same Bhuta class.

(B) Hetero-Bhautic Compounds—these may be bi- or poly-Bhautic compounds formed by the union of heterogeneous atoms of the different Bhuta classes.

The characteristic of Kanada's atomic theory is the assumption of the atoms as the indivisible ultimate particles of matter with eternal life. They are thus indestructible. Though eternal in themselves, they are, however, non-eternal as aggregates. As aggregates they may be organic and inorganic. Atoms are also conceived of as spherical in shape. According to Kanada, the variety of substances of the same Bhuta class, as well as of mono- and poly-Bhautic compounds, results from variation in the collocation of atoms and configuration of molecules. Thus a conception of the arrangement of atoms in space constitutes an essential part of Kanada's theory of chemical combination.

The Atomic Theory of the Jainas[7]

The atomic theory of the Jainas (*circa* 40 A.D.) is characterized by a very remarkable and interesting contribution to the subject of chemical combination. It relates to their analysis of atomic linking and the mutual attraction or repulsion of atoms in the formation of molecules. The Jaina system of philosophy holds that the different classes of elementary substances (Bhutas) are all made up of the same primordial atoms. Hence, the same kind of interatomic forces is involved in the formation of chemical compounds, as well as of molecules, from atoms.

According to the Jainas mere juxtaposition of atoms or molecules is not sufficient to bring about chemical combination. An interlinking between atoms or molecules must precede all compound formation. Matter (Bhuta) in the Jaina philosophy is called Pudgala, which exists in two forms: Anu (atom) and Skandha (aggregate). Linking is possible only between two particles of matter of opposite character. One must be positive and the other negative. Such opposing qualities are illustrated, for instance, by roughness and smoothness, dryness and viscosity, etc. Two homogeneous particles, both positive or both negative, cannot unite if their qualities be of equal magnitude. But attraction between two such similar particles may occur leading to a linking or combination between them if the magnitude or strength of the quality characterizing the one is twice or greater than twice as that of the other. All changes in the qualities of the atom and the physical properties of the aggregate depend on this linking. The Jaina view thus seems to bear a family resemblance to the Dualistic Hypothesis of chemical combination propounded by Berzelius nearly after eighteen hundred years.

A significant feature of all the physico-chemical theories of the ancient Indian philosophers lies in their assumption that molecules and atoms are always in motion (*parispanda*). Such motion is generally conceived of as a vibratory or rotary motion. All action, operation and work are ultimately traced to this atomic and molecular motion. This vibratory motion (*parispanda*) is a symbol of cosmic evolution. For, we have already seen that Prakriti as the unmanifested and ultimate ground with Gunas in equilibrium, where the cosmic evolution is under arrest, is devoid of all vibratory or *parispanda* motion.

The Scientific Method of the Early Indians

A knowledge of the doctrine of scientific method of the early Indians is essential for the proper assessment of values of their achievement in the domain of positive science, and for the matter of that, in chemistry. For, without a rigorous and reliable methodology the pursuit of science degenerates either into a collection of empirical recipes, or into idle dreams and fanciful speculations. But in the various philosophical systems of early Hindus, particularly in the Nyaya system, in numerous texts on the Buddhistic system of philosophy, and in many authoritative ancient treatises on inductive and deductive logic, as well as on grammar, medicine, meteorology, astronomy, biology, chemistry, etc., the development of a genuinely scientific method of thought, observation and experimentation can be clearly discerned. A few typical instances, by way of illustration, might convince even the most sceptical critics. Everyone knows today that at the foundation of science there are two fundamental assumptions without which science could not progress and becomes altogether meaningless. These are stated in the form of laws and are known as the Law of

Uniformity of Nature and the Law of Causality. [illegible] these laws were thoroughly recognized by the [illegible] Hindus and were elaborated with meticulous care about two thousand years before their final establishment in Europe at the time of Galileo, when science turned from cosmology to mechanics. In [illegible], these laws gained an unusual significance during the Buddhistic period as they constituted the very basis of the teachings of Gautama Buddha, embracing both the animate and inanimate nature. According to this Hindu methodology of science truth can be discovered, or an information on any subject obtained, by means of perception, observation and experimentation; the condition of each, their [illegible] and limits, were also studied with great care. Importance of observation and experiment has been particularly emphasized in the ancient medical [illegible] like Charaka and Susruta. In the latter particularly, ingenious directions are given for dissection of dead bodies for purpose of demonstration, and post-mortem operations as well as operations in obstetric surgery are described for embryological observations. It is also well-known that observations of the movement of planets and stars reached a remarkably high order of perfection as was possible under the prevailing circumstances. Study of meteorology also was based upon similar careful observations of weather and various atmospheric phenomena. Therapeutics in Charaka also offer an excellent illustration of the application of genuinely scientific method for the study of special problems relating to [illegible], their cause, symptoms, and remedies. Experiments, as the essential means of discovering facts, have been described in treatises on [illegible], metallurgy, medicine, etc. Their importance was greatly appreciated in relation to arts and industries like dyeing, perfumery, metallurgy and manufacture of glass. Over and above, elaborate discussions on safeguards against fallacies of observations, *viz.*, malobservation, hallucination, predisposition, etc., on the doctrine of inference (*anuman*) based upon causal relations and the uniformity of nature, and on the criteria of a correct and legitimate hypothesis for the explanation of facts, in many philosophical treatises of the early Hindu and Buddhistic periods, leave little room for doubt regarding the positively and genuinely scientific character of the methods followed in ancient India for the pursuit of knowledge and the ascertainment of truth, whether scientific (*Vijnana*) or philosophical (*Jnana*).

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[1] Bruhl, The Philosophy of Auguste Comte, London, 1903.

[2] Siva or Hara is the name of a Hindu god of the post-Vedic period, who is one of the Hindu trinity, Brahma the creator, Vishnu—the preserver, Maheswara or Siva—the destroyer.

[3] History of Hindu Chemistry, Revised Edition, Vol. I, Calcutta, 1925.

[4] According to some authorities Nagarjuna lived during the second century A.D., but we adhere to the more modest estimate.

[5] History of Hindu Chemistry, Vol. I, p. 195.

[6] Colebrooke, *Trans. Roy. As. Soc.*, Vol. I, p. 579.

[7] Preface to the Samkhya Karika, 1837, p. ix.

[8] For more details see B. N. Seal's article in Ray's History of Hindu Chemistry, Vol. II, p. 59.

[9] Jainism is a religious cult very much alike to Buddhism, being based on the principle of non-violence. But the Jainas are much more rigorous in their observance of non-violence than the Buddhists. Thus, while eating of the flesh of dead animals is permissible to the Buddhists, the Jainas would never take any animal food including even eggs.

[10] For a fuller account see Seal's article in Ray's History of Hindu Chemistry, Vol. II, p. 225.

BIOLOGICAL RESEARCH AND TAXONOMY

N. L. BOR,
INDIAN FOREST SERVICE (RETIRED)
and
D. CHATTERJEE,
ROYAL BOTANIC GARDENS, KEW, ENGLAND

MAN is by nature a systematist, that is, he likes to be able to distinguish by name between one object and another, he puts like with like in larger groups and within his own little world, classifies and arranges the different things with which he comes into daily contact. That this is so, is manifest when the vocabulary of any primitive people is examined. This will contain names for all the objects in which the tribe is interested. The Nagas have many scores of names to distinguish varieties of rice, Job's tears, maize and so on. On the other hand he gives one name to the blackberries although they are distinct morphologically to the botanist. He classifies such plants by a generic name as it were. In the course of time such blackberries as are good to eat are separated from those that are unpalatable, the varieties with red fruits are differentiated from those with black fruits, and so on, until in time a system of classification is evolved which meets the needs of primitive man. Similarly, a primitive people whose principal interest is fishing will have a name for any fish they come across, a tribe interested in hunting will distinguish by name all the animals and birds within their area.

As may be expected primitive tribes have a sound knowledge of those plants and animals which are good to eat, those which are unpalatable and those which are definitely poisonous. They also have a traditional lore regarding medicinal plants. It was no accident therefore that the first books to be written about plants dealt with medicinal plants. In the third century B.C. Theophrastus wrote his *"Enquiry into Plants"* in which he clearly recognized several hundred species and actually was cognisant of the two modern taxonomic groups *Umbelliferae* and *Compositae*.

After this, systematics seems to have languished until the sixteenth century. In this period the illustrated herbal of Brunfels (1530) appeared as well as other works on botany. These herbals and books dealt with plants which were interesting either medicinally or in some other way, without showing any speculation into the relationship of the plants to one another.

Up to this time there had been a great advance in the intercourse between nations, and the more adventurous of the seafaring nations penetrated into unknown parts of the world, and there saw wondrous plants, animals and other curiosities. Man is also a born collector. An inspection of any school boy's pocket will give sufficient evidence of that and it was inevitable that collections should have been made if only for the purpose of substantiating stories of adventure. At any rate collections of plants and animals began to accumulate, mainly in Europe, at the beginning of the seventeenth century. It was felt early in the eighteenth century, that some method had to be evolved in order to classify the material, name it, and provide means whereby any specimen could at any future date be referred to the appropriate pigeon-hole.

The greatest advance towards this goal was the contribution by the Swede, Carolus Linnaeus, who introduced the binomial system of nomenclature and whose book *"Species Plantarum"* (1753) is one of the most important works in systematic botany. He published a system of classification based primarily upon floral characters in which the number and distribution of stamens were of primary importance. By his system botanists were able to classify and name the known plants of those days. We now know that many unrelated plants came to be grouped together by such a system but it was a magnificent effort and gave an enormous impetus to the study of systematics.

Linnaeus was followed next in importance by Jussieu who recognized the number of cotyledons, by which he separated the broad groups of flowering plants, and subdivided the major groups by making use of epigyny, perigyny and hypogyny. Considerable improvement was made on Jussieu's system by de Candolle, Bentham and Hooker, Eichler and others who applied to systematics, anatomical discoveries made possible by the gradual perfection of the microscope.

In 1859 Darwin published his *"Origin of Species"* in which the principle of evolution and effect of environment and isolation were demonstrated, and over which controversy lasted for many years. It was not long, however, before systematists accepted the principle and began to think and classify along the lines of phylogenetic relationships.

It is at this point that "systematics" ends and "taxonomy" begins. Systematics, strictly speaking,

the bare bones, the mechanics, as it were of classification, whereas taxonomy is classification according to the principles of evolution, and implies a sorting out and regrouping of plants and animals based on phylogenetic relationship. From this time onward systems of classification were designated as "natural" as opposed to the older "artificial" systems. Bentham and Hooker, von Sachs, Engler and Prantl, Wettstein are honoured names of those who made great progress, towards the end of the nineteenth century, to produce systems of classification which endeavoured to keep pace with current evolutionary thought.

At the beginning of the twentieth century several avowedly phylogenetic systems were published—the last of which, and perhaps the most important of them, is that of Dr J. Hutchinson of Kew. In this system the ancient distinction between arborescent and herbaceous habit is made the basis of the classification, so that the phylogenetic tree starts from the woody *Magnoliales* and the mainly herbaceous *Ranales*. While many botanists differ on points of detail in the phylogenetic system, it can be said that the majority agree that it is a distinct advance on older systems and has provided a basis for healthy controversy that cannot but bring good in its train.

The fossil record has revealed much regarding the ancestry of the ferns, gymnosperms and cycads but it is very extraordinary that, up to the present time, nothing has been brought to light which indicates a definite ancestry of the angiosperms.

Some phylogenists derive the group from the gymnosperms, while others point to a hypothetical ancestor of both the *Bennetitales* and the *Angiosperms*, while others again suggest the *Caytoniales*. All we can say at present is that the verdict on any of these theories must be, "non proven".

Up to this point systematics and taxonomy were erected mainly on the foundations of morphological similarity and the meagre fossil record. To that however, must be added that intuition, "sense" or "feel" call it what you will, possessed by all the great systematists, which leads them to place groups and individual plants in their correct phylogenetic position. Such gifts are not given to all and cannot be acquired by reading, even though this be wide and deep, but will come after vast experience in dealing with plants.

As an example of the manner in which taxonomy receives support and correction from other sources one may mention the Koenigsberg school of serum diagnosis. This method developed by Mez, consists essentially in extracting a protein from a plant and mixing it with serum either in an animal or *in vitro*. After a suitable period another protein extract from a different plant to be tested, is added. The formation of a precipitate indicates relationship,—the heavier the precipitate the closer the relationship. A phylogenetic tree constructed from the results of this work at Koenigsberg confirms to a large extent theories based on comparative morphology. Further, the wood anatomist can often give very valuable advice when sterile material has to be identified or when a new genus has to be relegated to its family. Cytologists can help enormously to elucidate the nature and origin of species.

At this point, some twenty or twenty-five years ago, the taxonomist was forced to take stock and reorientate his ideas owing to the enormous advances made by the biological sciences—genetics, cytology, ecology, and physiology.

The working biologist and the systematist now realize that pure systematics or taxonomy will not do and that there must be a wider approach to the many problems which have come to light in the last twenty years. The mass of accumulated data, patiently acquired, must now be examined afresh and it is this realization which has inspired the book *"The New Systematics"*. A perusal of this book will reveal what difficulties confront the taxonomist whether he be a botanist or a zoologist. These difficulties will not be solved by the cytologists, geneticists, systematists, or ecologists working in water tight compartments in their respective fields of work.

There must be a much wider exchange of knowledge if progress is to be made and that progress cannot be made if biologists working on living material do not publish their work in such a way that the result of their research will be available to and exactly understood by scientists in other lands.

It is for this very reason that correct identification is of such paramount importance and the taxonomist is quite well aware of his responsibilities in this matter. The taxonomist is often blamed for altering names and splitting well known species and it sometimes seems as if his critics believe that he does it for the fun he gets out of it. A systematist does not alter names without very good reason and does not split or lump species without valid grounds. What he is aiming at is the stabilization of nomenclature and not its multiplication. At the present time nomenclature is in a state of flux but stabilization cannot be far off. At any rate the rules of nomenclature have been agreed upon and it behoves all biologists to have a proper knowledge of the rules themselves and the recommendations under them.

A worker in any field of research would be well advised to consult a systematist regarding the object of his research as one cannot expect a cytologist, geneticist or other worker to be a competent systematist as well as being an expert in his own line.

Correct identification is particularly necessary in cytological work in which chromosome counts are based on living root-tips of specimens grown from seed since what is obtained from sowings may not be, and often actually is not, what the seed is supposed to be. It is not uncommon to find published work based upon material which has been incorrectly identified or not identified at all. Such work is quite valueless and only misleads a worker in other countries with the result that it has to be done all over again.

In ecological work the correct identity of the individuals which combined together make up the very complicated community which is the object of study, is vital and, if possible, should be backed with herbarium sheets of the species. This fact is often lost sight of in published work and while an ecologist may be also a systematist in Europe or America where the number of indigenous species is small, it is a very different matter in India where the species of flowering plants is not far short of 18,000. With such a wealth of flora it is quite absurd for biologists working on plants to think that they can dispense with the aid of a competent systematist. What is wanted in India at the present time is a higher proportion of trained systematists who by virtue of their training and knowledge of the published literature can prevent biologists from going off the rails.

Pitfalls to be avoided by the biologist and especially the young biologist are many. The senior author well remembers one case in which a scientific paper was to be presented to a scientific meeting. The subject of the paper was the occurrence of an *Urticaceous* species in the dry and arid area of Rajputana. As the species in question was an inhabitant of the moist and steamy forests of Assam, the report of its having been found in Western India was of considerable interest. But when the specimen was produced it was found that a common local species had been confounded with its relative from Assam. Had the mistake not been discovered in time the habitat of the Assam plant would have been extended 1500 miles to the west and would have been recorded in the literature for all time.

An example of teamwork in biological research is afforded by the discovery in India of a substitute for the lignum-vitae of commerce (*Guaiacum officinale* Linn.) The wood of this species is very heavy and hard and by virtue of its high resin content is of vital use in pressure bearings. During the recent war, supplies from America were short and a substitute was sought for. The Forest Research Institute, Dehra Dun was consulted and it was found that certain samples of what was commonly called *Acacia catechu* (Linn. f.) Willd., compared very favourably with the properties of true lignum-vitae. The wood technologist (Dr K. Chaudhury) and the systematist (Mr M. B. Raizada) took the matter further and it was discovered that the wood came from *Acacia chundra* Willd.,* a distinct species which had been sunk in synonymy under *Acacia catechu* (Linn. f.) Willd. The systematist was able to point out certain morphological details by which the two could be separated and the valuable tree identified in the field.

Nobody in their senses would dream of erecting a plant for the production of penicillin without first getting a competent systematic mycologist to confirm the identity of the fungus which is to produce the drug. There are over 500 species of *Penicillium* which resemble each other closely and it is only the trained systematist who can confirm that the species to be used, is *P. notatum* Westling, and not some closely allied species which does not produce penicillin. Perhaps it is because money is involved that such factories maintain mycologists on the staff. But surely the value of a biologist's scientific reputation is above the price of pearls to himself and he would be well advised to work in close co-operation with a systematist trained in the taxonomy of the group he is working upon.

There does not seem to be in India that close liaison between biologists and systematists which is considered essential in America and Europe, to ensure that the results of research are presented to the scientific world in proper form. The matter of correct nomenclature has already been touched upon but, in order to emphasize the point, must be considered further.

The *Flora of British India*, magnificent effort though it is, should not be considered the be-all and end-all of plant names in India. It must be remembered that at the end of the last century a very wide view was taken of the limits of the species and even of genera. Research in cytology, anatomy and taxonomy have tended to narrow the limits of species so that, to-day, plants which had been merged in other species have been revived and given their full status, be it that of species or genus. All this research has been published in the scientific journals of many lands, for research on Indian plants is by no means confined to India. The names are abstracted and published in the well known *Index Kewensis*. Despite this, however, one continually finds published work which still persists in using out-of-date or even incorrect names. There are hundreds of plant names in the *Flora of British India* which are the result of misidentification. If an Indian biologist insists on

* This spelling is to be adopted being published earlier (Sp. P. 4, 1078, 1806) although Roxburgh in 1819 (Cor. Pl. 3, 19) and DeCandolle in 1825 (Prod. 2, 458) used the epithet "*sundra*".

using such names his research is valueless or of very local interest only.

Indeed, Hooker and his collaborators were well aware that the *Flora of British India* was to be considered only as the sweeping together of an enormous mass of material into a convenient form, suitable for intensive study at a later date. Ever since the *Flora of British India* appeared, Indian plants have been studied not perhaps with the intensity that the flora merits, but, at least, as intensively as the funds provided have permitted. The results of these studies are to be found in the pages of a large number of scientific journals and books. It is the business of the taxonomist to keep himself up-to-date in the literature so that he can answer the questions of his biological colleagues. It is equally obvious that biologists should consult the systematist, but does he do so? We doubt it.

In recent reports on agricultural statistics from Indian Provinces, in which scientific names of the crop and other economic plants appear, we find the following generic names: -*Hardemum*, *Recenies*, *Nicotrapa* and *Hyristica*. We doubt whether any of our botanical colleagues, except the expert crossword solvers, would recognize *Hordeum*, *Ricinus*, *Nicotiana* and *Myristica* without some scratching of heads. This instance is nothing in itself, but is apt to cause amusement and a bad impression abroad. In all truth the world wants gaiety and amusement but this can be better provided in other ways than by the perpetration of scientific howlers. If these scientific names are of so little account that errors like the above escaped scrutiny, it is better to drop them altogether. A systematist, if consulted, would have detected these errors and a dozen others in these reports at a glance.

One final word to those who control the purse-strings of biological research in India. Do not starve your biological institutes of trained systematists and above all do not deprive them, gifted though they may be, of the all-essential library of world periodicals and a first class herbarium. The amount of biological research which remains to be done in India staggers the imagination. India has the potentialities of making a great contribution to universal biological knowledge, but she will not make it, if the systematist is regarded merely as an unnecessary appendage and not as an essential part of the machine.

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PRODUCTION OF SULPHA DRUGS FOR BACILLARY DYSENTERY IN INDIA

U. P. BASU

THE BENGAL IMMUNITY RESEARCH INSTITUTE, CALCUTTA

INTRODUCTION

THE treatment of bacillary dysentery with Sulphonamide drugs is now well established. The drugs which have been commonly used are Sulfaguanidine, Sulfathiazole, Sulfadiazine, Sulfabenzide, Sulfasuxidine (Succinyl Sulfathiazole) and phthalidine (Phthalyl sulfathiazole). A fair amount of literature is available on the comparative merits and demerits of each of these drugs in various types of bacillary dysentery caused by organisms such as Shiga, Flexner, Sonne, Schmitz, Boyd, and New Castle strains. Judging from the more frequent incidence (about 53%) of Flexner infections in India, it would appear that Sulfadiazine should be considered the drug of choice, as this has a high therapeutic rating against bacilli of the Flexner group, both in acute infections as well as in 'Carrier cases', comparatively low toxicity, better tolerance and less chance of forming insoluble acetyl derivatives in the urinary tubules. Sulfabenzide (Sulfanilyl benzamide) is another drug which is almost next in value, as this also has a low toxicity (Bose, *et al*, *Ind. Med. Gaz.*, *80*, 385, 1945) and is a well-tolerated (Bose & Ghosh, *Ind. Med. Gaz.*, *32*, 61, 1944) drug, with particularly marked effectiveness against *Sonne* type bacillary dysentery organisms, reported to be responsible for about 14% of all dysenteric infections in India (Leishmann & Kelsall, *Lancet*, 1944, *ii*, 231). During epidemics of bacillary dysentery which are not uncommon in India, a combination of these two sulpha drugs in suitable dosage proportions would appear to be in-

dicated, as this would take care of both Flexner and Sonne type infections, thus accounting for nearly 70 per cent of the bacillary dysentery patients and convalescent carriers. On a recent statistical computation, 2·5 million people are stated to be affected by bacillary dysentery alone in India. On this basis, the target of production of Sulpha drugs of this class would come to thousands of pounds, the relative proportion between Sulphadiazine and Sulphabenzide being about 4 : 1

Production of Sulpha Drugs

Considering that more than 2·5 millions of people suffer from bacillary dystentery and that 15 to 18 gms (30-36 tablets) of sulfadiazine and/or sulfabenzide would be sufficient for the clinical treatment of each case, the minimum requirement of sulpha drug for this disease alone would exceed 1,00,000 pounds per year. If the proportion of the two drugs be accepted in the ratio of 4 to 1, the requirements for sulfadiazine would be over 80,000 pounds. Of course, sulfadiazine is also required for the treatment of other coccal infections and its target of production may exceed 2 lakh pounds in all (*cf.*, the Report of Fine Chemical and Pharmaceutical Panel, Government of India). Under these circumstances sulfabenzide may be prepared up to a limit of 20,000 lbs.

Sulfadiazine

There is no legal difficulty in producing sulphanilamide but the other sulpha drugs are mostly covered by patents. The sulfadiazines (sulphanilyl pyrimidine derivatives) may be easily produced from sulphaguanidine by reacting with 1, 3-diacarbonyl compounds

$$NH_2.C_6H_4SO_2NH-C\begin{matrix}\diagup\!\!\!\diagup NH\\ \diagdown NH_2\end{matrix} + \begin{matrix}OC.R\\ |\\ CH_2\\ |\\ OC.R'\end{matrix}$$

$$\longrightarrow NH_2.C_6H_4SO_2.NH-\begin{matrix}N & - & C.R\\ \| & & \|\\ C & & CH\\ | & & |\\ N & = & C.R'\end{matrix}$$

but the process has been patented by the Society of Chemical Industry in Basle (Ind. Pat., Nos. 29273 and 29493). The Haffkine Institute has taken certain patents on Sulphapyrimidine derivatives, *e.g.*, Ind. Pat. Nos. 27999 and 28971. But these are not complete and the latter is further dependent on sulphaguanidine which is covered by a patent (Ind. Pat., 28363) by American Cyanamide Company (*cf.* also Ind. Pat. 29858). Messrs Imperial Chemical Industries have taken two patents on the preparation of sulphaguanidine (Ind. Pat., Nos. 29526 and 29613). The latter process involves the interaction of iso-thiourea with sodium salt of sulphanilamide in presence of phenol to give rise directly to sulphanilyl guanidine.

$$NH_2.C_6H_4.SO_2NH.Na + RS.C\begin{matrix}\diagup\!\!\!\diagup NH\\ \diagdown NH_2\end{matrix} \xrightarrow{\text{Phenol}}$$

$$NH_2.C_6H_4SO_2NH-C\begin{matrix}\diagup\!\!\!\diagup NH\\ \diagdown NH_2\end{matrix}$$

A similar reaction conducted by Das Gupta and Gupta (*Jour. Ind. Chem. Soc.*, *22*, 333, 1946) between the sodium salt of sulphanilamide with ethyl sulpho-cyanide afforded sulphanilyl-cyanamide:

$$NH_2.C_6H_4SO_2NH.Na + C_2H_5S.CN \longrightarrow NH_2.C_6H_4SO_2NH.CN$$

The latter when heated with dry ammonium nitrate in presence of phenol also yields sulphaguanidine according to the equation (*cf.* Ind. Pat. 31754):

$$NH_2.C_6H_4SO_2NH.CN \xrightarrow{NH_4NO_3} NH_2.C_6H_4SO_2\,NH-C\begin{matrix}\diagup\!\!\!\diagup NH\\ \diagdown NH\end{matrix}$$

From the above it may be noticed that the difficulty may not arise for the production of sulpha-guanidine, but the preparation of sulfadiazine would be handicapped due to the existence of the patents owned by the Society of Chemical Industry in Basle, as already referred to. In the larger economic interests of the country, certain improvements of Sections 22 and 23 of the Indian Patents and Designs Act seem to be necessary. The Section 22 (compulsory licenses and revocation) provides that a patent may be revoked if the patentee fail to grant licenses on reasonable terms, or, if any trade or industry of the country is unfairly prejudiced by the conditions attached by the patentee. The Section 23 (revocation of patents worked outside British India) provides a revocation of any patent if the patented article or process is manufactured or carried on exclusively or mainly outside British India. The country is now in a position to produce these synthetic chemicals. Of course at the initial stage certain raw materials and appliances are to be imported. The nature of reactions involved in such synthetic chemical preparation is known to the technicians of the existing industries, and once a production is started, it may be easily expected that with the gain in knowledge in large scale technique for synthetic chemical production, the industry would be in a position to meet the requirements of the country.

The starting material for sulfaguanidine may be either sulphanilamide or even acetanilide itself. But for synthesising the guanidine derivative from acetanilide we will have to produce chlorosulphonic acid and guanidine in sufficient quantity within the country. To start with the production of sulpha drugs, we need not wait for all these raw materials to be manufactured in India. For the present it would be better to prepare sulfaguanidine from imported sulphanilamide. The sulfaguanidine may be subsequently converted to sulfadiazine by the process already indicated. While the production from imported materials continues, attempts should be made to undertake the production of various raw materials with a view to making the country self-sufficient in future.

In this connection it may be stressed here that the use of synthetic drugs in modern medical practice is increasing from day to day. It is essential that the manufacture of all these is taken in hand immediately from chemicals available in India and from materials that are to be imported in bulk for the present. Even under such conditions, the various products can be synthesised in India at prices much cheaper than the prevailing market prices. Some help from the Government in the form of subsidies, however, would be necessary at the beginning.

Sulphanilylbenzamide

As has been mentioned above, the target of production of this sulpha drug may be about 20,000 pounds if sulfadiazine be simultaneously produced. Otherwise this alone may also be safely used in all dysentery infections. Its non-toxicity would further promote its use in the treatment of infants and in patients very sensitive to any sulpha drug therapy. For its production benzoyl chloride, sulphanilamide and acetic anhydride are the chemicals that are to be imported for the present from abroad. The method of its preparation is known (Basu and Sikdar, *Jour. Ind. Chem. Soc.*, *22*, 344, 1946) and it involves the following reactions:

$$NH_2.C_6H_4SO_2NH_2 \xrightarrow[\text{Anhydride}]{\text{Acetic}} Me.CO.NH.C_6H_4SO_2NH_2 \xrightarrow{Ph.COCl}$$

$$Me.CO.NH.C_6H_4SO_2NH.CO.Ph \xrightarrow{H_2O} NH_2.C_6H_4SO_2NH.CO.Ph.$$

This compound under the trade name "Sulfabenzide" is already being produced and marketed by Bengal Immunity in the form of tablets of 0·5 gm. each. The general characteristics and pharmacoepial standards of the product have been recently recorded (*cf.*, Basu and Sikdar, *Pharm. Jour.*, *159*, 48, 1947).

In any large scale production of sulpha drugs certain special type of appliances would be necessary and these will have to be imported from abroad. Open glass-lined vat, glass-lined kettle with stirrer, jacketted kettle, stainless-steel filter press, centrifugal filters with stainless-steel buckets and certain other appliances would be necessary in particular. It would also be proper at this stage to contact some manufacturers of the raw materials, as well as, of the above appliances and with that end in view some chemists and chemical engineers from this country may be deputed to see the large scale synthetic operations in some manufacturing organisations of England and U.S.A. This visit would simultaneously help in the development of other fine chemical industries.

Conclusion

It appears that for the mass treatment of bacillary dysentery in India, sulphadiazine and sulphanilyl benzamide would be the drugs of choice. The targets of production would exceed 80,000 lbs. for the former and 20,000 lbs. for the latter and these would be sufficient only for 2·5 millions of patients suffering from bacillary dysentery per annum.

The difficulty of production of sulphadiazine may be avoided by importing sulphanilamide and converting the same to the diazine through sulphaguanidine. The production of the latter would not be difficult from any angle but for converting the same to sulphadiazine, Section 23 of the Indian Patents and Designs Act might need some modifications. Sulphanilyl benzamide is already being produced. Its large scale production, however, would need certain imported raw materials from abroad at present.

Government should help the manufacture of drugs and pharmaceutical chemicals by offering certain subsidies to Indian manufacturers in ways that can be decided by a Special Board appointed for that purpose.

UTILIZATION OF POWDERED MICA WASTE

S. K. MUKHERJEE.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, U. S. A.

Introduction

MICA is an essential commodity in the construction of almost all types of electrical machinery. The total tonnage used is small compared to any other important mineral or chemical, but it is one of the 23 commodities on the list of "strategic" materials approved by the Army and Navy munitions board. Its services extend from the generation of the current, through hundreds of diversified activities—from sending a radio message to toasting a piece of bread.

There is plenty of poorly crystallised or finely divided mica throughout the world—materials that are useless for these electrical purposes—most of which is called scrap or waste mica. Mica that answers the specifications of electrical needs occurs only in limited quantities and in relatively few places of the world, India being the chief source which supplies more than 80 per cent of the world's needs, the rest being supplied by Madagascar, United States, Canada, Russia, Brazil, and also very little from few other countries. Sheet mica which only is important to the electrical trade must be cleaned and dressed from the associated impurities before it can be effectively utilised. This is entirely a manual operation and requires skilled cheap labour—a factor which has again given India an advantageous position in the industry, in addition to her vast natural deposits.

In the manufacture of mica parts from sheet mica, there is necessarily a large loss of material. Also, as much as 85 per cent of the block mica as mined is lost as waste in the process of rifting it into sheets and subsequent trimming the sheet. In the process of making finished parts from the sheets, a further loss of 45 to 60 per cent is incurred as wastes from the punching machines and as defective pieces. Thus, a large quantity is produced as a necessary by-product. Such production takes place in all crude mica producing countries, but only in the United States is such scrap mica utilised in important quantities; in other countries, it is thrown over the dump, excepting when circumstances permit it for export, particularly to the United States.

Sources of Waste Mica

There are several important sources of waste mica, chief amongst which are the following:

I. *Clay Deposits*.—When granites or felds-spars are decomposed and hydrated and thereby become clay—a process of nature that takes ages to accomplish—the accompanied mica resists decomposition and remains in the resultant clay, from which it can be recovered—and the clay is made purer and the cost of such purification is more than compensated by the value of the mica recovered.

II. *Mica Schist*.—These occur in nature in many stages of purity, the chief impurity being clay. Those of a very high mica content are used. The mica is somewhat loosely knit together, and the schists always contain foreign matter to necessitate concentration after crushing. The mica content is about 33 to 92 per cent.

III. *Mining from Scraps and Recovery from Dumps*. There are several prolific mica deposits that yield practically no sheet mica and that are operated for scrap only, ground mica being the final finished product of the mills to which the scrap is shipped.

IV. *Reclaimed or Clay Bank Mica*.—These are usually sufficiently fine before grinding, and the mica content is about 90 to 92 per cent.

V. *Factory Scrap*.—The waste product of the sheet mica punching and manufacturing plants which amounts to about 50 per cent of the weight of the original sheet is a very important source for the wet grinders of high quality mica. This for the most part being purer mica is thus treated, and commands an excellent price.

Mica Grinding Operations

The ease with which thin layers of a mica crystal flake off and separate from each other, together with the fact that they are both relatively soft and tough, makes the grinding of mica a more difficult process than the usual grinding operations and specially designed equipments and processes had to be developed. United States is possibly the only country in the world where these operations have been brought to a high degree of perfection and possibly she supplies the entire world demand of ground mica. Only highly industrialised countries of Europe and Japan used to import ground mica from United States, others being finished goods.

Grinding is by either the dry or the wet process. Dry grinding is accomplished in many types of mills, the chief amongst which is the hammer mill. Two stage grinding is usually employed, and the product is usually separated into grades of different degree

fineness by screens of different mesh. Pure mica content in the finished product is about 92 to 97 per cent.

Wet grinding is done by wooden rolls. The water content of the charge must be watched very carefully. If too much water is used, proper grinding is precluded, and if too little is used the mica will burn and lose its sheen. After grinding, it is allowed to settle in a series of tanks, and the suspension of finest particle is dried either directly or after filter-pressing. The mica is then bolted through 160 to 300 mesh cloths according to specifications. In all of the operations, care must be taken to keep it clean and free from iron stain. The final mica content is about 93 per cent.

Uses and Applications of Ground Mica

The wet ground differs from the dry ground in that it retains its sheen and lustre. The most expensive use for this is in wall paper where the silvery sheen effects are produced by wet ground mica used in the printing. About 50 per cent of the wet ground mica are used for this purpose. Mica scrap ground dry is less expensive product than the wet ground material, and is largely employed for the manufacture of roofing paper extensively used in this country.

In addition to roofing and wall paper manufacture, paint and rubber industry are its principal consumers. Other uses are in ceramics, as a boiler and steam pipe lagging and mica mats for boiler coverings. Its sound producing and detecting capability has been utilised in making diaphragm for acoustics purposes which goes into various sound producing and detecting devices. Mica spectacles have been used in Germany to protect the worker's eyes from chips and splinters, and mica goggles to shield the eye against glare and intensive heat of the oxy-acetylene flame.

Mixing ground mica (325 mesh) with aluminum bronze powder to save aluminum has produced a paint having superior resistance to salt air and chemical fumes. Micronised mica which is being exclusively produced by one North Carolina Company yields a product marketed as 100 per cent passing through the equivalent of 3000 mesh and used as an extender or filler in paints and plastics. Biotite—another group of mica minerals—similarly ground is used in lubricating greases, leather finishes and other special applications.

Sericite mica or secondary white mica formed by the alteration of the feldspars during weathering and subsequent decomposition is extremely fine grained. It can be ground much more easily and requires only light disintegration and washing to yield a 325 mesh product. This is used mainly for casein paint. Although selling for less than half the price, it is claimed to be better than ordinary waterground mica in varnishes and certain other protective coatings' because it lacks sheen yet retains the fish scale forms, which is one of the superior property of wet ground compared to dry ground mica.

Attempts have been made to utilise inferior quality ground mica in fertilisers as a source of potash. Potash has been extracted from mica by such drastic treatments as fusion with ammonium chloride and subsequent leaching with hot water or by the extraction with moderately concentrated HCl. Since the potash in mica is not readily exchangeable with other ions due to its stable position in an unit parcel, the prospect of readily getting available potash for the growth of the plants in the soil does not seem to be very rosy. However, potash will slowly pass into the soil and become available to the plants if the mica is extremely fine grounded so as to increase the amount of cleavage surface.

Threat to Indian Mica Industry

India's position with regard to the mica industry has been unique. Already, synthetic mica has come into the picture. Two different products have been artificially prepared which have all the properties of mica. Germany developed a synthetic mica from simple inorganic compounds which they were using during the war. The process, however, does not seem to be economical and could only be justified as an emergency measure. Another synthetic mica has been developed by Prof. Hauser of Massachusetts Institute of Technology by a comparatively simple method of exchanging the base in the lattice structure of bentonite clay films with electrolytes having a cation like potassium. These films approach mica in their electrical properties, and were extensively used during the war in the construction of various electrical equipments. Attempts are also being made to develop equipments for splitting block mica into sheets mechanically, though limited success has so far been achieved. With all these progress in the industrialised nations, India might be thrown out of the picture if right now she does not take vigorous steps in re-organising her industry on a sound basis.

A plea for a Ground Mica Industry in India

Numerous uses of ground mica have been briefly stated and many more will doubtless be found with progress in applied research. The product is in great demand, but it is a pity that India with all her advantages as to natural resources has so far failed to

set up a mica grinding industry of her own. Instead mica waste is being shipped to U. S. only for such a simple unit operation as grinding by mechanical means. The most logical location for such an industry should be in India and not in U. S. and she should export finished ground mica rather than waste scrap. With industrialisation in India, there will also be a huge demand for ground mica for its diversified uses. Agronomists are of opinion that under suitable conditions, ground mica can be successfully used as a source of potash for plant foods, and India's needs for such manures are well known. A mica grinding industry should be set up immediately so that, in future, India can maintain a favourable export trade with other countries and barter critical materials for her essential needs.

HYDROLOGY OF THE DAMODAR VALLEY

N. K. BOSE

DIRECTOR, RIVER RESEARCH INSTITUTE, BENGAL

A MULTIPURPOSE development of the Damodar Valley has been decided upon by the Government of India in collaboration with the Governments of Bengal and Bihar. This scheme of development has been mainly based on the Preliminary Memorandum submitted by the Central Technical Power Board of the Government of India in 1945. The raw data drawn upon by the framers of this Memorandum were derived mostly from the gauge readings initiated by Addams Williams in 1913 and the few discharge figures of the maximum known floods also calculated by him. The memorandum had also made use of the more exact hydrological observation of the river system started by the River Research Institute, Bengal, in 1944. These observations are still being continued and this note has been written to describe what exactly is being done in connection with these observations.

These observations were started in July, 1944 for implementing one of the recommendations of the Damodar Flood Enquiry Committee set up by the Government of Bengal in 1943 after the disastrous breach and flood of the Damodar river in July of the same year. Three silt laboratories, eight observation sites and four gauging sites were opened on the river Damodar and its tributaries during 1944-45 (See Fig.). A number of rainfall and runoff stations have also been opened at some of these sites. The staff employed on this work consists of 3 Research Assistants, 3 Overseers, 1 Runoff Supervisor, 8 Silt Surveyors, 3 Senior Runoff Observers, 11 Gauge Readers and a number of menials. The whole work is under the control of an Assistant Engineer of the Institute and the raw data obtained are examined in the Statistical Section of the Institute.

The following observations are being carried out at these sites:—

GAUGING SITES

These have been located at the four proposed dam sites, Tilaiya, Maithon, Ayre and Sonalapur for noting river gauges only. The river stretches here are very wide and due to the torrential nature of these streams it is not possible to take discharge observations by boats at these sites. Gauges are, therefore, taken at these places and by correlating these gauge readings with the gauge readings taken at some suitable sites in close vicinity where discharges can also be measured, the discharges at the dam sites are being obtained. By this method it has been possible to obtain the "Rating Curves" for the dam sites.

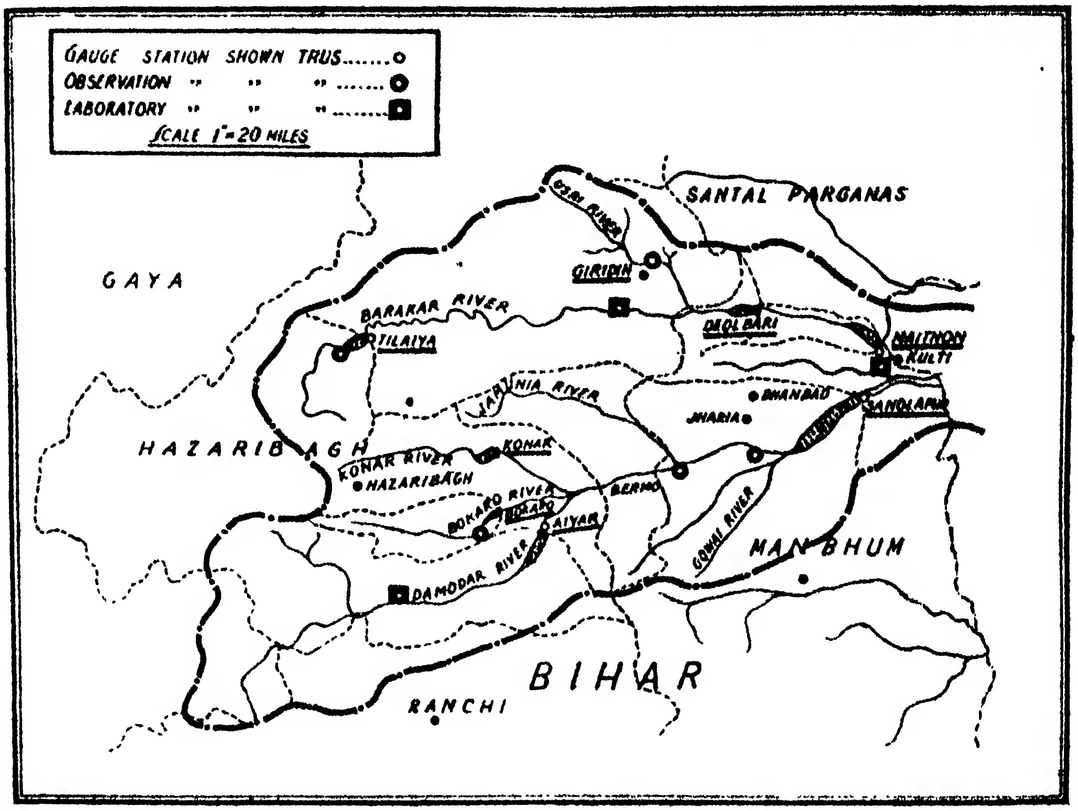
OBSERVATION SITES

These observation sites have been located at suitable stretches of the river Damodar and its tributaries where railway or road bridges are available. These bridges have been utilised for equipping the sites with arrangements for obtaining the following information:—

(a) *Gauge Reading.*—The bridge piers have been utilised for this purpose. Temporary gauges have also been put up to know the slope of the water surface in the stretch and thereby to calculate velocities by any of the recognised methods (Kutter's, Manning or Lacey). These serve as a check to the velocity observation actually carried out by floats. The gauges are read all throughout the year and at frequent intervals during the day.

(*b*) *Cross sections* of the river are taken as frequently as possible. During floods it is not always possible to take them. They are sometimes carried out from over the bridge by sounding.

(*c*) *Velocity observation.*—These are done by dropping floats. Due to the rocky nature of the bed and very rapid flow it is not possible to use current meters. The floats are dropped from over the bridge and timed over a stretch of 1000 ft. or so. Velocities are taken twice a day usually but more frequently during floods.



THE UPPER DAMODAR VALLEY WITH DAM SITES, RESEARCH LABORATORIES, OBSERVATION AND GAUGE STATIONS

(*d*) *Silt sampling.*—Water samples are collected by a special type of loaded bucket from over the bridges. They are collected usually twice a day and more frequently during floods. Total solids, percentage of particles coarser than ·6 mm., total salt and *p*H values are determined.

Silt Laboratories

These are situated at three of the observation sites. They are equipped for analysis of silt intensity, proportion of coarse sand, determination of *p*H and total salt. Bed sand samples are analysed in the Central Laboratory at Calcutta.

Rainfall Runoff Observation

There are three stations for these observations located in the valley. They have been selected with a view to represent the different surface conditions of the valley. They are provided with rain gauges and runoff trays. Rainfall is generally recorded once a day but during a cloud burst they are observed more frequently. Runoff and soil erosion from different trays are recorded once a day normally but at the end of every cloud burst also. It may be mentioned here that in the Damodar Valley a cloud burst generally lasts for 3 to 5 days and they are followed by almost dry days even during the rainy season. Cloud bursts of moderate intensity are not infrequent even during the cold months.

Analysis

These raw data are collated and analysed in the Statistical Section of the Institute. Gauge Curves, Hydrographs and Rating Curves are worked up for all the twelve sites. Total volume of flood water during a complete flood season and volume of flood flow for each cloud burst are calculated. The volume of silt and sand carried by the river at different points, during the whole year and during each flood are worked up. Runoff ratios are obtained for the whole flood season, for each flood and for different stages of the same flood. "Unit Hydrographs" have also been derived for the catchment areas controlled by the sites.

Rainfall, Runoff and Soil Erosion from the separate trays at the different sites are analysed for different parts of the year, different cloud bursts and for different stages of the same cloud burst. Runoff

ratios are worked out and compared with the values obtained from discharge observations. They compare very closely. Soil erosion for different parts of the season and for different streams yield very interesting results. Comparison of soil erosion and runoff with reference to the nature of the surface soil afford some illuminating study.

Future Programme

These observations have been continued for the last four years. There had been no extra-ordinary heavy flood during these years. The maximum recorded at Rhondia was 3,500,000 cu/sec in 1946. This is a medium flood for the Damodar. Methods of these observations are being improved every year. It is proposed to introduce a new type of silt sampling at all these sites next year. It may be mentioned that these are hill streams and in consequence torrential. The ordinary methods of bottle sampling are not applicable here. Special type of loaded bucket samplers had to be devised for these sites. The present method allows considerable improvement some of which are expected to be taken up next year.

Vast improvements are contemplated in runoff experiments. It is proposed to enlarge the size of the trays and take the catchment of small streams as one unit. Three such units have already been selected. Special measuring devices will be set up at these streams.

It is proposed to take up more detail observations of the meteorological factors covering the valley in collaboration with the Central Waterways, Irrigation and Navigation Commission. This will be taken up under the scheme of working out the 'Water Balance of the Damodar Valley'. This will be the first valley in India that will receive such comprehensive treatment. India Meteorological Department will also co-operate in this scheme. The scheme briefly is as follows.

The investigation will be sub-divided under the following subheads:—

(a) Rainfall and Evaporation.—This work is to be carried out under the aegis of the Meteorological Department for which the Director General, Meteorological Department has already given his estimates.

(b) Runoff and Erosion Experiment.—These experiments are being carried out by the River Research Institute, Bengal. It is proposed to extend these investigations to a bigger scale. Up till now they are being carried out in small trays. It is expected that some hill streams with catchment areas approximating ·2 to ·5 sq. miles will be taken up in this connection. Details of those experiments are being worked out.

(c) Subsoil Flow and Regeneration.—River Research Institute, Bengal, proposes to take up this work in the near future. It has drawn up a programme of work for this item.

(d) Discharge and other hydraulic observations.—These are being carried out by the River Research Institute, Bengal. There are, at present, 12 gauging stations all over the valley with 2 additional stations in the plain.

(e) Water requirements of Crops and Vegetation—It has been proposed that the Director, Pusa Institute, Delhi, be requested to take up this work in collaboration with the Central Waterways, Irrigation and Navigation Commission. Some field experiments will be taken up in this connection.

Application of the information so collected

One may naturally ask why are such intensive investigations of the hydrology of a river valley necessary. For the multipurpose development of a valley it is absolutely essential to know its hydrological possibilities. The planning and design experts must know the maximum probable discharge volume that the river can bring, the seasonal distribution of these discharges, the maximum runoff from different catchments. These are all necessary to design the spillway capacity of the dams. A knowledge of the volume and nature of silt and sand brought down by the river and its different tributaries, their distribution during the different parts of the year is essential before the 'dead storage' required for the dams may be fixed. It has been found in many of the American dams that by taking advantage of the presence of 'Density Current' in some of the streams it has been possible to eject considerable volume of harmful silt from the reservoir and thereby extend its useful life considerably. It is also known that all the tributaries of the river do not bring in the same quantity and quality of silt and sand. Advantage is taken of this fact to draw out the maximum volume of harmful silt from the reservoir with the minimum wastage of useful water. It is also well known that the nature and extent of vegetation cover on soils affect very materially the volume and rate of runoff. The observations carried out so far in the Damodar Valley have given reliable indication on these points. The effect of different vegetation covers has been investigated and their usefulness completely demonstrated.

It is expected that the investigation so far carried out in the Damodar Valley will give useful information to the Planning and Design Experts and help them to draw up a reliable and comprehensive Multipurpose Development Scheme for the Valley.

SIR ROBERT ROBINSON

NOBEL LAUREATE IN CHEMISTRY, 1947

SIR ROBERT ROBINSON, Professor of Chemistry, University of Oxford has been awarded the Nobel Prize in Chemistry in 1947 for his researches in Organic Chemistry. He is one of the foremost organic chemists in Great Britain today and is the second British organic chemist to win the Nobel Prize, the first being Prof. W. N. Haworth. As a recognition of his outstanding works in various fields of Organic Chemistry Sir Robert has been the recipient of Copley Medal of the Royal Society in 1942, Franklin Medal in 1946 and Paracelesus Medal of Swiss Chemical Society. He was the President of the Chemical Society of London (1939-41) and became the President of the Royal Society in November, 1945 and is after Sir William Crookes, the second past-president of the Chemical Society to assume the most important office in British Science.

SIR ROBERT ROBINSON

Sir Robert had his early training under late Prof. W. H. Perkin, at whose instance he devoted himself to the study of the chemistry of the alkaloids and other natural products. In 1917 he put forward theories regarding the formation of the alkaloid skeletons in nature by using comparatively simple reactions and his brilliant synthesis of Tropinone in confirmation of his views, earned him a great distinction as an organic chemist. He has carried out extensive investigations in elucidating the structures of various alkaloids, particular mention should be made of his work on morphine, strychnine and brucine. The formula of morphine as suggested by him is now universally accepted. Even now he is continuing his investigations on the chemistry of the alkaloids brucine and strychnine, for which he has suggested constitutional formulae.

His contributions in the field of natural colouring matters are equally brilliant. In paying tribute to Richard Willstatter Sir Robert wrote 'With the simultaneous growth of precise information about chlorophyll, the carotenoids, the polysaccharides and the terpenes, one may say that all the more obvious challenges of vegetative Nature to the organic chemist have been taken up and taken up successfully. The chemist of the future will be able to allow his eye to range over the flaunting pageantry of the summer garden with quite such a degree of complacent satisfaction as can the discoverer of magnesium in chlorophyll and the explorer of the territory of the anthocyanins'. Tributes in more glowing terms may also be paid to Sir Robert himself for his extraordinary and monumental work in elucidating the structures of and the synthesis of the red and blue colouring matters of the numerous flowers and blossoms (known as anthocyanins) and the colouring matters known as flavones and flavonols present in the plants. The synthetical methods developed by him have led to the synthesis of the natural colouring matters of the flowers *e.g., cyanin,* the colouring matter of the corn flower, *pelargonin*, the colouring matter of the scarlet pelargonium and a host of other colours of the blossoms.

Since 1934 he has been carrying on researches on the synthesis of sterols, bile acids and hormones. He has published a large number of papers describing methods to build up the complex polycyclic fused ring systems present in the above class of compounds. In this field he has developed a number of ingeneous methods of considerable potentiality. The synthesis of compounds of this class has been engaging the attention of the chemists and it must be said that but for the pioneering work of Sir Robert, the little success that has been achieved would not have been possible. The synthesis of the synthetic oestrogen stilbosterol may be mentioned. The results of his investigations on the chemistry of Pthioic acid, the fatty acid isolated from *Tuberculosis bacilli*, are also interesting.

Besides these contributions in the synthesis of natural products Sir Robert has done notable work in theoretical organic chemistry, particularly in the explanation of organic reactions in the light of the electronic theory.

Sir Robert is recognized as a leading organic chemist and it must be said to his credit that he has tackled most successfully the intricate problems covering a wide range. His contributions towards the elucidation of the structure and the development of the chemistry of the wonder drug Penicillin, are also considerable.

D. C.

Notes and News

ALLAHABAD UNIVERSITY

To mark the sixtieth anniversary of the foundation of the Allahabad University, a Special Convocation was held on December 13, 1947 at Allahabad. Her Excellency Mrs Sarojini Naidu, Chancellor of the University presided. Dr Rajendra Prasad, President, Indian National Congress delivered the Convocation address. Addressing the graduates, Dr Prasad advised them to take the path of moral conquest adopted by Mahatma Gandhi. He deplored the lust of power in the world today and to bring back man from this obvious destruction, the path lies in the revival of the ancient culture of India. It is the path of self-conquest, of service and renunciation and of co-operation and creation.

Referring to man's mastery over nature, the discoveries of science, the annihilation of distance, and the conquest of time, Dr Prasad said "Science has divorced itself today from morality. The man of science does not concern himself with the question of whether his discoveries are being used to good or evil purpose. The greatest triumph of modern science, the atom bomb, will always be associated in the minds of man with the dying wail of thousands of innocent men and women whose life was suddenly brought to an end." Continuing, he said that it is for this reason that sages of our land, emphatically declared that self-conquest is the supreme triumph of man. More than 2,000 years ago, Emperor Asoka renounced all conquest except *dharma vijaya* (victory of moral law). Mahatma Gandhi has been again giving this ancient message to the people of India and the world. Concluding Dr Prasad emphasized that the need for mankind, if it is to survive, is to hark back to the supremacy of the moral law and take to the path of self-conquest.

To mark the diamond jubilee of the University, *Honoris Causa* degree of doctor of science was conferred on Pandit Jawaharlal Nehru, Sir Shantiswarup Bhatnagar, Sir Venkata Raman, Dr B. C. Roy, Prof. Meghnad Saha, Prof. Birbal Sahni, Mr J. R. D. Tata, and Sir M. Visvesvaraya. The degree of doctor of law was conferred on Sir Mirza Ismail, Pandit Amarnath Jha, Mr D. K. Karve, Maharaja of Nepal, Mrs Vijaylakshmi Pandit, Pandit Govindballabh Pant, and Sir S. Varadachariar. The degree of doctor of literature was conferred on Maulana Abul Kalam Azad, Mr V. P. Kane, Dr K. N. Katju, Dr B. C. Law, Prof. R. D. Ranade, Sir Tej Bahadur Sapru and Mr Purushottamdas Tandon.

30TH ANNIVERSARY OF BOSE INSTITUTE

The 30th Anniversary of the Bose Institute, which coincided with the 89th birthday anniversary of the Founder Acharya Jagadish Chandra Bose was celebrated on November 30, 1947 under the presidency of His Excellency Sri C. Rajagopalachari, Governor, West Bengal. Dr J. N. Mukherjee, Director, Indian Agricultural Research Institute, New Delhi, delivered the Ninth Acharya Jagadish Chandra Memorial Lecture on 'Some scientific and practical problems of agriculture in India'.*

Paying his tribute to the memory of those who fought and suffered to bring about a great and free India, the Director of the Institute (Dr D. M. Bose) added that there were others, not workers in the political field, who by their lifelong activities have added new significance and value to the culture and civilization of this ancient land. The Founder of the Institute was one such creator of Modern India, a scientist, who believed that Science to be fruitful must be pursued in beautiful surroundings, and that scientific truth gained in significance when expressed in suitable, and therefore beautiful form. Formulating his famous generalization on the similarity of response in the so called living and non-living substances Acharya Jagadish Chandra was the first Indian scientist of note to interpret his scientific

* Full text of Dr Mukherjee's lecture will appear in a subsequent issue of the journal.

discoveries in terms of the philosophical concepts current in this country.

The aim of the Institute as conceived by the Founder was the advancement of Science by research and popularization of its results by lectures. The first idea of starting such an institute occurred to him in 1891 when lecturing before the Royal Institution, London, on his electric wave apparatus. For twenty years he was maturing plans for an institute and collecting funds, which included savings from his none too large income, legacies from friends, and donations from the public. By the time the Institute was started on November 30, 1917, the Founder's ideas had deepened, and he defined its object to be 'the further and fuller investigations of the many and ever opening problems of the nascent science which includes both Life and Non-life'.

During the last few years the Institute is devoting an increasing amount of attention to the application of science to problems of agriculture, industry and medicine. The recent division of India has deprived the Indian Union of some of its principal sources of cereals, cotton and jute. Further, Western Bengal has been deprived of its principal agricultural institutions situated at Tejgaon, Dacca. Plant breeding experiments including selection of suitable types, hybridization and evolving of new strains by means of X-ray irradiation have been undertaken in the Institute with cotton and jute plants; some long stapled disease resistant and early maturing types of cotton suitable for cultivation in Bengal have been produced. Similarly by X-ray irradiation unusually tall jute plants with large basal diameter have been evolved; trials regarding their stability must be undertaken before they can be released for large scale cultivation. Breeding and manuring trials with different strains of rice, local and imported, have been going on for several years.

The experience acquired for this type of work makes it feasible for the Institute to co-operate with the Department of Agriculture in all types of breeding experiments, seed selections, and seed multiplication of economic plants. It is expected that the Institute may help in this way, the realization of the ideal of self sufficiency for cereals and other economic plants in West Bengal. Physiological investigations on the nuitritional and other physiological requirements of young cinchona plants and as well as the cytogenetics of the different species of cinchona are being undertaken with a grant from the Central Government.

The Institute is receiving grants from the Board of Research on Atomic Energy and from the C.S.I.R. for fundamental investigations in Nuclear Physics and Cosmic Rays. Plans for long-range investigations in these two subjects as well as schemes for making the Bose Institute an All-India Centre for Biophysical Research, and also for development of the Founder's physical instruments for modern research purposes, have been submitted to Central authorities including the Ministry of Education. Provision of funds for the last two objects will be a suitable memorial to the pioneer work of the Founder of the Institute in short electric waves and in biophysics, extending over a period of forty years.

The Institute is at present feeling an acute shortage of laboratory accommodation, and any scheme for enlarging its activities as outlined above, as well as for the training of a larger number of research students, as contemplated by the Scientific Man Power Committee, will require the erection of additional buildings. The Director expressed a hope that both the Government of West Bengal as well as the Central Government will provide adequate grants for this purpose which will further increase the usefulness of the Institute.

CHEMICAL VACCINATION OF PLANTS AGAINST INSECTS

CHEMICAL vaccination of plants against insect attacks has been achieved by United States science by adding a powerful insecticide to the soil.

Built-in protection from such pests as red spiders, aphids and nematodes is provided for 1,800 square feet of garden space by a single pound of sodium selenate which is readily absorbed by plant tissues. Unfortunately, selenium also is poisonous to man, so that the treatment must be limited to flower beds and ornamental plants.

Excessive doses of selenium can harm plant tissue, but scientists at the Battelle Memorial Institute, Columbus, Ohio, found that the addition of gypsum to the soil protects the plants without lessening the effectiveness of the insecticide

Although absorption of selenium by a vegetable crop following a floral crop on soil treated with selenium has not yet been thoroughly investigated, treatment with gypsum may also have a desirable restraining effect on selenium absorption. Leaching between crops is said to be effective. (*Industrial and Engineering Chemistry, 39,* 16A, 1947).

BETTER AND CHEAPER NATURAL RUBBER

That cheaper and more uniform natural rubber will be made available by a recent advance in the processing of raw latex, is predicted in a report in "Industrial and Engineering Chemistry," a publication of the American Chemical Society.

Introduction of modern industrial methods of continuous production, with concurrent savings in time and factory space, is made possible by a new chemical treatment which speeds the formation of solid rubber from liquid latex, the report declares, asserting that coagulation time is reduced from several hours to only one minute.

The latex is poured into one end of a vat and swept toward the other end by paddles, while certain chemicals, such as fatty acids and fatty alcohols are added to hasten coagulation, it is explained. By the time the latex reaches the opposite end of the vat, it has turned into a lumpy mass and can be fed through a series of rollers that press out the excess moisture. By regulating the speed of the paddles and the amount of chemicals added, it is possible to make the process continuous and virtually automatic, the report adds.

This process represents a tremendous gain over the primitive technique that has been used since the days of the first rubber plantations in Malaya, the report points out. The older method, in which the latex is coagulated slowly in small moulds and fed by hand through the rollers, consumes much time, requires an undue amount of factory space, and does not always produce a uniform material, it is said. (*Industrial and Engineering Chemistry, 39*: 978, 1947).

INDIGENOUS MEDICINAL PLANTS

A SYMPOSIUM on 'The Scope of Cultivation of Indigenous Medicinal Plants in India' was held on Saturday, December 6, at the Indian Museum Hall, under the auspices of the Botanical Society of Bengal, Calcutta.

Prof. G. P. Majumdar, President of the Society, presided.

Opening the symposium, Mr S. N. Bal (Director of Pharmacognosy, Government of India) referred to the fact that India 'possesses about 2,500 plants of medicinal importance of which about 300 are mentioned in the British Pharmacopoeia and the British Pharmaceutical Codex and we find that 50 per cent of the pharmaceutical drugs are found in India in the wild state, and there has been no incentive to consider the farming of these. Besides a large number of medicinal plants used in *Ayurvedic* system of medicine are also chiefly obtained from wild conditions'.

With the partition of India, the question of making the Indian Union self-sufficient of her drug requirements the problem of cultivation is brought to the forefront. The aim of cultivation would be further to improve the quality of the drugs of uniform value, and put a check to the use of adulterated and spurious drugs. This is now imperative with the enforcement of 'The Drugs Act, 1940'.

Continuing Mr Bal referred to the organization known as Bureau of Plant Industry attached to the Department of Agriculture in U.S.A., where all questions relating to the development of drug cultivation are dealt with.

The society urged the Government of Bengal and the Central Government to undertake immediately a complete survey of vegetable drug resources of the country and of the available industries and with this end in view a committee be set up on the models of U. S. Bureau of Plant Industry, with representative of botanists, chemists, pharmacognocists, pharmacologists, and physiologists.

SMOKELESS AND FUEL SAVING HERL *CHULA*

A NEW type of smokeless 'HERL' *chula* (cooking oven), has been invented by Dr S. P. Raju, Director, Engineering Research Department, in Hyderabad State. The new *chula* possesses 'five freedoms', as the inventor claims for it, namely, freedom from smoke, soot, heat, fatigue and waste, all of which are the well-known defects of all ordinary *chulas*.

The *chula* is simple in structure, built of brick and mud plastered with fine earth. It consists of an "L" shaped duct with three holes for the cooking pots, and an opening for the firewood. At the end of the duct is an arrangement for heating a big pot of water. The gases find their way out of the cooking range by means of a chimney. A simpler type is also devised that would cost the villager not more than three to four rupees.

This new *chula* should prove, to be a boon to every household in India and we draw the attention of our readers for wider publicity.

SOUTH AFRICAN SCIENCE

WE are in receipt of the first number of *South African Science* published by the South African Association for the Advancement of Science. This new monthly would cater for the active scientific worker, a medium for dissemination of scientific knowledge and helping individuals to publish short research items with a minimum of delay. The journal would also act as an information Bulletin for the Association's activities. The columns of this new journal is also open to contributors who are not members of the Association.

Following the general policy of the Association, matter will be published in both the official lan-

uages of South Africa,—English and Afrikaan, as ey will be presented by the authors themselves.

The number under review (August, 1947) include ticles on 'Scientific Research in South Africa' and The World View of the Physicist'. Contents also include Book Reviews, Letters to the Editor, Notes and News, etc.

We wish our new contemporary a bright future tering a link of South African men of Science, with the rest of the world. Contributions are to be ddressed to The Editors, South African Science, P.O. Box 6894, Johannesburg.

INDIAN CENTRAL JUTE COMMITTEE

A DECISION to change the constitution of the Indian Central Jute Committee, consequent on the partition of India into two dominions was adopted at a meeting of the Governing Body of the Committee held in Calcutta on December 11, 1947, under the chairman of Sir Datar Singh, President of the Committee.

The Committee is of the opinion that the production of jute in the Indian Dominion could be increased by nearly 20 lakhs bales by growing early varieties of jute as a second crop in some of the lands now entirely confined to *Aman* paddy in Bengal, Bihar and Orissa. The area under *aman* crop in these three provinces was approximately 10 million acres, a considerable portion of which could be utilized for immediate cultivation of jute by adopting a system of double-cropping. It was also agreed to give 50 acres of land at the Chinsura Agricultural Farm to the Committee for housing the staff and laboratory equipment of the Committee's Agricultural Research Laboratory now at Dacca.

The meeting also decided the immediate establishment of five research centres for investigation into economics of jute growing in the Dominion of India. Of these, two will be located in West Bengal and one each in Assam, Bihar and Orissa. In order to increase the supply of jute seeds, the Committee felt that a sum of Rs. 1,50,000 should be provided as advance without interest to provincial governments, repayable in five years, for the establishment of seed multiplication farms.

Attempts would also be made to make available to the cultivators the results of research through the medium of leaflets and brochures written in simple Indian languages.

Mr I. G. Kennedy was elected vice-president of the Committee for fifth consecutive term.

CALCUTTA GEOGRAPHICAL SOCIETY

THE Thirteenth Annual General Meeting of the Calcutta Geographical Society was held in Calcutta on the 20th December last, with Dr W. D. West, a Vice-President of the Society in the chair.

The retiring president Dr B. C. Law in his Presidential address emphasized the role geography may play in the planning and development of the resources of independent India. It is a matter of satisfaction, said he, that inspite of the abnormality of situation in India and elsewhere the activity of the Calcutta Geographical Society has not been much hampered. Geography which has now gained the position of a science is immensely practical in its application. It is a synthetic science largely dependant for its data on the results of specialized sciences such as astronomy, physics, geology, pedology, hydrology, oceanography, meteorology, biology and anthropology, and always having respect to the natural regions of the world. It has undoubtedly a purely academic interest to those who pursue scientific investigations for their own sake, but that is a matter of importance only within the four walls of a College or the University. Now in the changed circumstances it is required to prove its great usefulness in everyday life. Before any new national planning is conceived or taken up for consideration, a foreknowledge of the earthly situation is a desideratum, and geography, which is nothing but the exact and organized knowledge of the distribution of phenomena on the surface of the earth, is to meet the requirement. This means that a Society like this and similar other organizations have got to create by all possible means an atmosphere of research and enquiry whereby students, economists, industrialists, politicians, and educationists, may direct their attention to all things, men and places, in short, all that go into the make up of a progressive collective life. Nearer home, let us take, for instance, the difficult and puzzling question of the all round development of West Bengal as an economically self-sufficient province even in its present reduced size and a much healthier and more prosperous habitat of an increasingly large population. We need increased measures of irrigation, sanitation, communication, roads and waterways, transport facilities, growing food-grains, industrial plants for timber, jute and sugar and other raw materials. To improve the sanitary condition of a place we are in need of easy and cheap natural drainage by restoring and opening canals and leading them into nearest rivers. To improve and increase our water way communications and transport we urgently need to divert, train, and dredge the existing rivers. Here in such matters geography will be an useful aid by the timely supply of maps, drawings, and sketches, indicating the present and past positions and conditions, beds, and courses of rivers and canals concerned. Geography along with geology, mineralogy and the like can be a constant guide to

working up a scheme for an improved method of agriculture and farming. Geographers are called upon to furnish necessary information as much about what is on the surface of the soil and what is beneath it. We have to seek constant guidance from them regarding the nature and direction of the periodical winds and climatic conditions in house-building and other important operations.

Those who want to make a special study of the subject need proper guidance. Their attention should be drawn to the problems awaiting solution and the regions to be explored. They should not be allowed to study geography unaided by the present and past history of the study of geographical details becomes dull and incomplete. The students should be taught to realize that the relation between geography and history is similar to that between anatomy and physiology, one concerned with the early situation and the other with the life movement. A society like this can do a good deal towards the popularization of the practical side of geography by publishing popular books in English and other modern languages.

Now that India has attained freedom, pleaded the president, every effort should be made by our Government to diffuse geographical knowledge of our country and of foreign countries with which we have established diplomatic relations.

Presenting the annual report Dr S. P. Chatterjee, Honorary Secretary mentioned how the Society has all through the critical days of the country, served the cause of the nation by organizing Land Utilization Surveys, publishing detailed population maps based on field data and holding discussions on important topics so as to enlighten public opinion. The activities of the society, the Secretary pleaded, could be better utilized in the interest of the country should the Government and the people take keener interest in it.

The following office-bearers were elected for the session 1948-49:

President—Dr W. D. West; *Hony. Jt. Secretaries*—Dr S. P. Chatterjee and Mr N. K. Bose; *Hony. Asst. Secretary*—Mr D. Sen; *Hony. Treasurer*—Mr D. P. Ghosh; *Hony. Librarian*—Mr. B. Basu.

ANNOUNCEMENTS

AT a meeting of the 'Tea Conference' held in Calcutta recently under the chairmanship of Mr K. K. Chettur, Secretary, Ministry of Commerce, Government of India, it was decided to continue the 'Indian Tea Cess Act, 1903' for a further period of five years beyond March 31, 1948 and to enlarge the scope of the act, so as to provide the cess funds being utilized for research as might help the development of tea industry. The cess funds are at present earmarked for expenditure on propaganda purposes only, by promoting the sale and increasing the consumption in India and elsewhere.

A BILL to provide for the establishment of the Damodar Valley Corporation, on the lines of the Tennesse Valley Authority in the U. S. A., was introduced in the Central Assembly recently by Sri N. V. Gadgil, Minister, Works, Mines and Power. The main functions of the corporation would be to control floods in the Damodar, generate electric power for distribution and provide water for irrigation. (See *Science and Culture*, December, 1947, p. 246).

To organize research work in the different scientific and industrial concerns of India 'The Scientific Man Power Committee', Ministry of Education, Government of India has undertaken a survey with a view to recommend to the Government the needs of the different departments. For this purpose India is divided into four zones, and each zone is placed under an officer on special duty. The zones and the name of the officer is given below.

1. *Eastern zone* comprising Assam, West Bengal, Bihar and Orissa under Mr S. C. Sen Gupta, of the Education department, Government of India.
2. *Northern zone* comprising East Punjab, Delhi, U. P.; under Dr Narang.
3. *Southern zone* comprising Madras Presidency, under Dr T. S. Sadasivan, Professor of Botany, Madras University (on deputation).
4. *Western zone* comprising Bombay Presidency, C. P., Gujrat and Western States under Dr V. S. Shukla, Professor of Botany, Science College, Nagpur (on deputation).

MR P. Venkateswarlu, M.Sc., has been admitted to the D.Sc. degree of the Benares Hindu University for his thesis on "Molecular Spectra of Halogens". The thesis was adjudicated by a Board of Examiners comprising Prof. Robert S. Mulliken, Dr W. Jevons and Prof. R. K. Asundi.

ACKNOWLEDGMENT

WE acknowledge with thanks the receipt of the following :—

JOURNALS

Science—Vol. 106, Nos. 2740, 2741, 2742, 2743, 2744, 2745, 2746, 2748, 2750, 2751, 2753, 2754, 2755, 2756, 2757. *Scientific American*—Vol. 177, Nos. 2, 3, 4, 5. *Endeavour*—Vol. 6, Nos. 22, 23, 24. *Chemical Age*—Vol. 57, Nos. 1464, 1465, 1466, 1467, 1469, 1470, 1471, 1473, 1474, 1475, 1476, 1478, 1479. *Science and Society*—Vol. II, Nos. 3, 4. *Journal of*

...merican Chemical Society—Vol. 69, Nos. 7, 8, 9, ... Journal of Chemical Education—Vol. 24, Nos. 7, ... 9, 10. Discovery—Vol. 8, Nos. 8, 9, 10, 11. Sky Telescope—Vol. 6, Nos. 10, 11, 12 ; Vol. 7, No. 1. ...urnal of the Franklin Institute—Vol. 243, Nos. 1, 3, 4, 5, 6 and Vol. 244, Nos. 1, 2, 3, 4. Geographical Review—Vol. 37, No. 4. Beama Journal—Vol. 54, Nos. 121, 122, 123, 124. Science et Vie—Sept. 1947. Journal of the Scientific & Industrial Research—Vol. 6, Nos. 6, 7, 8. Current Science—Vol. 16, Nos. 8, 9, 10, 11. Journal of the Science Club—Vol. 1, No. 1.

BOOKS

1. Socialism and Ethics—Howard Selsam ; 2. Making your own Telescope—Allyn J. Thompson; 3. The Muria and their Ghotul—Verrier Elwin ; 4. Petroleum Resources of India—D. N. Wadia ; 5. Fertilisers and Manures—Ernest Vanstrue ; 6. The Soil and the Plant—Ernest Vanstone ; 7. Fundamentals of Electricity and Electromagnetism—Vernon A. Suydam ; 8. The Arboretums and Botanical Gardens of North America—Donald Wyman ; 9. A Hand Book of Printing Types—W. S. Cowell Ltd. ; 10. A Book of English Clocks—R. W. Symonds ; 11. Flowers of the Woods—E. J. Salisbury ; 12. The Chemical Kinetics of the Bacterial Cell—C. N. Hinshelwood ; 13. Timber—H. E. Desch; 14. The Elements of Physical Chemistry—Glasstone ; 15. Practical Plant Anatomy—A. S. Foster ; 16. Genera Filicum Edwin Bingham Copeland ; 17. Biologists in Search of Material—G. Scott Williamson & I. H. Pearse ; 18. The Song of God (Bhagavad Gita)—Swami Prabhavananda & Christopher Isherwood ; 19. The Brontes—Phyllis Bentley ; 20. Samuel Butler and The Way of all Flesh—G. D. H. Cole ; 21. The Mechanism of Contact Catalysis—R. H. Griffith ; 22. Plant Biology—H. Godwin ; 23. One, two, three, infinity—George Gamow ; 24. Practical Psychiatry and Mental Hygiene—Samuel W. Hartwell.

BOOK REVIEWS

An Elementary Text-book of Inorganic Chemistry —By Ramani Mohan Roy, M.Sc. (Gold Medallist), Ripon College, Calcutta, Pp. 506. Published by The Book House, Calcutta. Price Rs. 3/12.

The present volume covers the syllabus of the I.A. and I.Sc. courses in Inorganic Chemistry of the Indian Universities. The author has succeeded in presenting the subject matter in logically graded steps so that the beginners may not find any difficulty in following them. A special feature of the book lies in its emphasis upon the fundamentals and the avoidance of unnecessary details which are likely to burden the memory and bewilder the young mind. The book will undoubtedly be useful to those for whom it is intended.

P. R.

X-rays —By B. L. Worsnop and F. C. Chalklin, Pp. 128, F'cap 8vo. Published by Methuen & Co. Ltd., London. Price 5 *sh*.

The brochure under review is one of the monographs on physical subjects published by Methuen and Co. Ltd. Although the subject is a vast one, the authors have tried to include a brief survey of as many of its aspects as possible. The production of X-rays and measurement of intensity and absorption coefficient of these rays have been discussed in the introduction. In Chapter II attempt has been made to explain in detail how the wave length of X-rays was determined by Sir William Bragg with the help of his X-ray spectrometer. The next chapter deals with X-ray spectra. Starting with Moseley's law the authors have discussed Bohr's theory of atomic spectra. The origin of sub-levels in the K, L, M, and other energy levels has then been discussed briefly and a diagram showing the sub-levels in the first four energy levels has been included. The X-ray absorption spectra have also been discussed in this chapter and the origin of the absorption edges and the fine structure of these edges observed in the case of solids has been explained briefly. Chapter IV deals with scattering of X-rays and the Compton effect. The discussion on the latter phenomenon includes that on the broadening of the modified line due to the initial motion of the electron responsible for the modified scattering. Refraction and total reflection of X-rays and interference and diffraction phenomena similar to those observed with ordinary light have been discussed in Chapter V. The last chapter deals with the ejection of photo-electrons by X-rays and methods of measuring the

velocities of these photo-electrons. The significance of the observed results has also been discussed.

It has not been possible for the authors to include any detailed theoretical discussion on any of the topics mentioned above, evidently for want of space, and probably for the same reason no attempt has been made to explain the methods of analyzing crystal-structure with the help of X-rays. The brochure will, nevertheless, serve the purpose for which it has obviously been published, *viz.*, to help the scientists who are not specialists in X-rays to get themselves acquainted with different aspects of this vast subject. The brochure may also be useful to B.Sc. students who want to take up Honours course in Physics.

There are 47 diagrams and a short bibliography in this brochure. Considering the quality of paper and printing the price seems to be moderate.

S. C. S.

Dating the Past—An Introduction to Geochronology—By Frederick E. Zeuner, Published by Methuen & Co Ltd., London. Price 30*sh.* net.

Professor Zeuner has reintroduced the word "Geochronology" to designate in a comprehensive sense the science of dating in terms of an absolute time scale *i.e.* in years, those periods of the past to which the human historical calendar does not apply. It covers, thus, according to Zeuner, the period of human prehistory as well as the whole of the geological past. This definition is far more comprehensive than the earlier use of the same word by H. S. Williams who coined the word in 1893 to designate "studies in which the geological time scale is applied to the evolution of the Earth and its inhabitants." Schuchert in 1931 also used Geochronology in the strict sense of the calculation of the age of Earth on the basis of sediments and life.

Zeuner divides his book into four parts—the first part is the early historical period dating up to 1000 B.C. where the free ring methods have been usefully employed specially in the U. S. A. The second part covers the neolithic period which dates roughly from 15,000 B.C. and takes in some of the prehistoric civilizations of man. The general method employed is the analysis of deposits of layers of clay after the retreat of the last glaciers some 25,000 years ago. The varves as these stratified layers of clay are called have been extensively studied and an absolute time scale has been developed mainly for the North-European areas. The third part which covers approximately the paleolithic age of man for the last one million years is of great anthropological interest as this period covers the development of the various species of men and near-men. The pleistocene period which covers the last one million years is of interest to geologists because of the several periods of glaciation with intermediate warm periods when the glaciers retreated greatly. There are at least four periods of recognized glaciation and three interglacial relatively warm periods. Zeuner subdivides some of these periods even further by classifying the nature and types of moraine and deposits, and erosion. He correlates these subsections of the pleistocene ice ages of Northern Europe to the Mediterranean and North Africa to a lesser extent to Asia, Australia, America and the rest of Africa. The ice-chronology is fitted to the anthropological scale and the various species of men and their cultures are discussed in the background of changing climate and physical conditions. Prof. Zeuner's discussion of the development of the various species of the genus *Homo* is very well written although some of his conclusions may not be so easily acceptable to anthropologists like Sir Arthur Keith and others. The ease with which he traces the species *sapiens* from the middle Pleistocene (about 2,50,000 years) Swanscombe skull through Skhul cave men (Mt. Carmel, Palestine) and the Grimaldi negro to the present races of men may not be so readily acceptable. The fourth part which goes back to the beginnings the Earth deals with geological periods and discusses the Paleontological and Geological methods of estimating time. There is a short chapter on the applications of Radioactive methods to the estimation of geological time. The lead isotope ratio $_{Pb}{}^{207}/_{Pb}{}^{206}$ method of Nier is unfortunately not mentioned. There is an interesting discussion of estimation of time of biological evolution rate in the last chapter of the book. There is a fairly complete bibliography at the end of the book and twentyfour excellent photographic plates. There are also many illustrative sketches in the text and a good index. The book will serve as an excellent introduction to students of geology, paleobotany, anthropology, geophysics and into the thin common border subject of geochronology.

B. D. N. C.

Regional Keys for the identification of Important Timbers used in Military Areas of Inspection—By K. Ahmad Chowdhury, M.B.E., D.Sc., Indian Forest Records, Vol. 3, No. 7, 1945. Published by Forest Research Institute, Dehra Dun, U. P. Price Rs. 5-12-0.

A number of highly instructive and useful manuals on the technology of Indian timbers have been published by the Forest Research Institute, Dehra Dun, in recent years and these have met with a large measure of appreciation from the general

blic. The above number issued under "Utilisa-n Series" is a further contribution to our know-lge adding to the volume of technical literature it has already grown around the subject.

The author has presented the subject matter of s brochure in an attractive way so as to make it teresting and useful even to non-technical people gaged in the commerce and utilisation of the timber sources of this country. In part I, a preliminary count on the general structure and properties of od is given. The language employed is simple d is intended to serve as basic knowledge for derstanding the important characters used in aber identification. This is followed by instruc-ns about the technique of preparation and examina-. of timber samples. Then comes the key which been prepared according to the areas indicated n the map as Military Zones of Inspection, so as o be easily applicable to the respective areas. The distinguishing characters of the chief timber-yielding plants in each area are given and this is extremely eful in determining the botanical identity of the ecies.

Part II is devoted to the description of the struc-tural characters of the wood. The scientific names are arranged in alphabetic order followed by concise d scriptions of timber structure, the terms employed being explained in the Introductory Chapter. The common English and local names are also given for each.

Part III contains photomicrographs (57 plates) printed on thick art paper. The photomicrographic reproductions are quite clear in the matter of struc-tural details and are useful in rendering the matching of specimens a comparatively easy matter for pur-poses of identification.

A list of selected references given for purpose of collateral reading is also very useful.

On the whole, the information brought together in the above number is well-presented. It not only contains general descriptions of the structure of economically important timbers but also provides a succinct key to facilitate their identification with accuracy and ease, ensuring certainty in place of judging by general appearance alone which is apt to be confusing. Supplying as it does, a handy re-ference guide to the identification of the timbers generally sold in the Indian market, it is bound to have a large demand from not only foresters and botanists but from the commercial community as well.

The get up of the volume is good and its com-paratively low cost is within the reach of all to whom it may be useful. Its value would be considerably enhanced if short descriptions of external morpho-logical characters, vegetative and reproductive parts are added under each species as this would help in identifying the plants in the forest at first sight. Similarly, short notes on the peculiarities of struc-ture noticeable when timber is freshly cut, character-istic smell etc., would also be very helpful.

Another point which requires clarification is about the Laurel wood, which is supposed to be the product of *Terminalia crepulata* Roth and not *T. tomentosa*. There is some confusion with regard to this species.

K. B. and M. A. S.

Functions of a Complex Variable —By Thomas M. MacRobert. Publishers: Macmillan & Co. Ltd., London. Pp. 390. Price 18 *sh*.

The English language contains at present some good text-books on analysis and the theory of com-plex functions, and this book is one of them. The fact that it has now passed into the third edition speaks well of its excellence and popularity. The book is suitable for post-graduate classes of Indian universities, and serves a useful purpose by intro-ducing the student to the subject and preparing him for the study of advanced treatises.

The book starts with two chapters on the geo-metrical representation of complex numbers; then we have the usual chapters on analytic functions, inte-gration, Taylor's and Laurent's expansions, uni-formly convergent series, analytic continuation, etc.; next comes a chapter on Gamma functions followed by chapters on Weierstrassian and Jacobian elliptic functions; the remaining chapters contain a dis-cussion of the theory of linear differential equations and methods of their solution. In addition to these the book contains five appendices giving some addi-tional matter and detailed discussions. Although it is evident that some more chapters should have been included in it, *e.g.*, a full chapter on integral func-tions, nevertheless it is an excellent book and con-tains many fine exercises which will prove very useful to a serious student of the subject.

U. K. G.

Thermodynamics for Chemists —By Samuel Glas-stone. D. Van Nostrand Company, Inc. New York. Pp. viii + 522, 1947. Price 28 *sh*. net.

The book is undoubtedly an welcome addition to Glasstone's series of text-books, which are similar for their lucidity of exposition and simplicity of treat-ment. Thermodynamics is unfortunately considered by many as an abstruse subject. A reading of this book will undeniably show not only the varied types

of important applications of thermodynamic principles to many everyday chemical problems, but also the way in which they can be applied; the large number of problems, solutions of some of which are either worked out or indicated are in this respect immeasurably helpful to the students. Some topics of interest to students of chemical engineering have been discussed but it is not anticipated that the entire purpose of those undertaking a course in chemical engineering will be served. The reviewer agrees with the author when he states that time has come for statistical methods "to take their places as an essential part in chemical thermodynamics" But the treatment of the subject has been unfortunately, not perhaps necessarily, out of tune with the other chapters of the book The backgrounds of these subjects treated in chapters VI and IX could have been a little more elaborated for many of those for whom the book is intended, so that they could be read without any other helpbooks. The arrangement and treatment of the subjects are nearly the same as in the author's well-known Text-Book of Physical Chemistry, but in the present volume the symbols have been further Americanised. The large volume of numerical data either in the text or in the appendix have made the book very useful for purposes of reference to students as well as research workers.

S. K. M.

Health and Social Welfare, 1947 Published by Todd Publishing Company Ltd, 49 Park Lane, London. Price 25 *sh.* net

'Health and Social Welfare' is an annual British Publication which sets out in a handy form a large mass of information on every branch of the social services, health legislation, statements on policies by the Ministries and other official bodies concerned with social planning and administration, and also statements on their scope and activities by the many unofficial welfare organisations existing in Great Britain. That such a manual for ready desk reference is required by all those engaged in some way or other with constructive activities in the field of social and health services in a modern State was proved by the popularity of the first edition of this book, and this, the third edition, is likely to be more useful as this contains further additional up-to-date information and covers a more comprehensive ground, particularly in regard to the scope and organisation of, and possibilities of making a career in the medical and ancillary health professions.

The book is divided into 11 Sections. Section 1 contains 8 independent articles on subjects such as 'Housing and Health', 'Marriage Guidance', "Welfare in Industry', etc., which may be considered to be in the van of medico-social progress in Great Britain and other Western countries. Section 7 contains a useful article on 'Careers in Health and Social Welfare' which will repay careful reading as some of the suggestions contained therein could be profitably employed in developing health services under Indian conditions. Section 2 deals with 'Legislation and Policy' and discusses the objectives of the National Health Service of 1946 which aim to 'promote the establishment of a comprehensive health service designed to secure improvement in the physical and mental health of the people'. The other sections deal with 'Official and non-official Directories of Health and allied institutions and organisation in Great Britain and Colonial and Dominion Countries, officially-appointed Committees and their Reports, Statistics and Tables, Books, Periodicals and Films on Health and Medical subjects, and a 'Who's Who in Health and Social Welfare', etc. In fact, every relevant information on these matters has been incorporated, classified and grouped in a way which will enable readers to obtain the maximum benefit from reference work. In these days when planning and organisation of public health and social services are looming large in the minds of popular Ministries in the Indian provinces, an accurate and authentic information on the structure and pattern of the official and the numerous non-official associations and bodies operating in these fields for many years in Great Britain would serve as examples from which necessary ideas applicable to the peculiar needs of this country might be drawn. Everyone engaged in health and welfare services of this country should possess a copy of this reference book. The price is moderate.

B. M.

LETTERS TO THE EDITOR

[The Editors are not responsible for the views expressed in the letters.]

ON THE AFFERENT BRANCHIAL ARTERIES IN *OPHICEPHALUS PUNCTATUS*

In *O. punctatus* the occurrence of four pairs of afferent branchial arteries is a well known fact. The blood supply of the gills by the said arteries is a bit peculiar. The first and the second pairs of arteries supply respectively the first and the second pairs of gills, but the third pair supplies the fourth pair of gills and the fourth pair the third pair of gills. This latter fact is not on record so far.

As regards the roots of the arteries there is still a great confusion. Although Goodrich[1] and Kerr[2] have given diagrams of afferent branchial arteries of some fishes, they have not clearly described their origin.

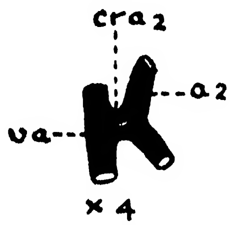


FIG. 1. Showing ventral aorta va and the common root cra_2 of the second arteries, a_2 (dorsal view). The root has been pushed to one side.

In some diagrams Kerr has shown that the first and second arteries are separate prolongations of the ventral aorta laterally on each side and that each of the third and fourth pair of arteries has a common root from the ventral aorta. But in the case of *Ophicephalus punctatus*, the second pair of arteries arise by a common mid-dorsal prolongation of the ventral aorta (fig. 1) *i.e.* they do not arise separately and directly as lateral prolongations of ventral aorta. The third and fourth arteries of each side arise by a common mid-dorsal prolongation of the ventral aorta (fig. 2); later the common prolongation divides into two common roots for the third and the fourth arteries on each side. Each common root again divides into third and fourth arteries. The third artery dorsally crosses over the fourth one and supplies the fourth gill; while the fourth artery dorsally passes below the third one and supplies the third gill.

Why there is such a peculiarity as to the nature of origin of the last two arteries? The real answer lies in the development of the ventral aorta and the afferent arteries, the detail works on which are in progress. The necessity of such peculiarity as related to the supply of the gills may in the opinion of the writer be explained in the following manner.

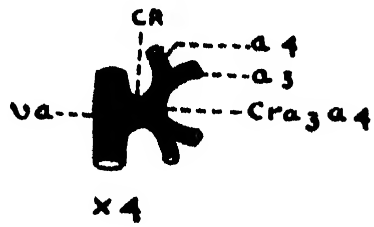


FIG. 2 Showing the ventral aorta, va, common root cra_3a_4 the third, a_3 and fourth a_4 arteries and also the common root, CR, of both the common roots of third and fourth arteries, (dorsal view). The common root CR has been pushed to one side.

It may be supposed that during circulation, the major portion of the blood, passes along the fourth artery and is achieved by its passing below the third artery which allows the passage of less quantity of blood due to the sharp curvature near the root. (Fig. 3)

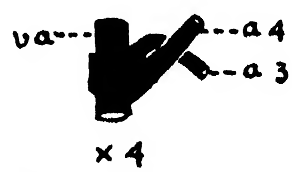


FIG. 3. Showing the ventral aorta and the paths of third a_3 fourth, a_4 arteries (ventral view).

In some cases the third artery is seen to be reduced in width in comparison with the fourth artery and the corresponding change is sometimes observed in the gills. *Anabas* also furnishes similar condition. According to Sedgwick[3] this condition in *Anabas* is due to the presence of accessory respiratory organ, a structure found in *Ophicephalus* also.

Zoological Laboratory, G. S. GHOSH
University of Dacca,
27-8-47.

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2 Kerr, J. G., Text book of Embryology II, London, pp. 360-428, 1919.
3 Sedgwick, A., A student's text-book of Zoology, London, pp. 200, 1905.

THE MECHANISM OF THE STABILIZATION OF THE MILK CLOTTING ACTIVITY OF FIG LATEX

FRESH latex of *Ficus carica* L. (edible fig.) loses its milk-clotting activity[1] at a fairly rapid rate at room temperature (23–25°C). The lost activity is partly restored by the addition of sodium cyanide, glutathione or cysteine. If, alternatively, glutathione or reducing agents like sodium cyanide or sodium hydrosulphite are added to the fresh latex immediately after tapping, the enzyme activity remains at its original level up to 16–20 hours. The loss of enzyme activity can also be partly arrested by keeping the *p*H of the latex at 4. The loss of enzyme activity in the unprotected latex is usually accompanied by a *p*H shift from the original 5·6 to 6·4. The latex contains a fair amount of vitamin C and the vitamin undergoes a parallel deterioration with the milk clotting activity on keeping the latex (Table I). Additions of reducing agents or sulphydryl compounds protect the vitamin and at the same time, help to restore and preserve the milk-clotting activity.

TABLE I

ACTIVITY PER GRAM OF LATEX

	Milk coagulating activity units*	Vitamin C in latex by dye titration
1. Fresh latex	4000	2·81
2. ,, ,, after 6 hrs. standing	2680	1·86
3 After adding 2 mg of glutathione to (2) . ..	3870	2·61
4. After adding 1·2 mg of NaCN, to (2) . ..	3920	2·67
5. Fresh latex + 1·2 mg of NaCN	4250	2·81
6. (5) after 16 hours	4250	2·80
7. Fresh latex + 2 mg. glutathione	4235	2·81
8 (7) after 16 hours .	4010	2·80
9. Fresh latex + 15 mg of Sod hydrosulphite	4000	2·80
10. (9) after 16 hours .	3900	2·73
11. Fresh latex adjusted to *p*H 4	4000	2·82
12. (11) after 16 hours .. .	3750	2·58

* The unit of enzyme may be defined as the activity required to clot 10 ml. of 20% Klim (whole milk) in acetate buffer (*p*H 4·6) at 37°C in 1 minute.

Ascorbic acid coexists with glutathione and other thiol compounds in the latex of papaya and functions as one of the natural activators of papain.[2] The thiols, in addition to activating and regulating the proteolytic process in the papaya, seem also to protect the vitamin against oxidation by peroxidase or copper.[3] The latex used by us was drawn fresh from the fig plantings in the Institute nursery and has consistently given negative tests for thiols with nitroprusside and for cysteine with dimethyl-p-phenylamine and Ferric Chloride[4] even after preliminary reduction with H_2S gas. Expressing the dye titre value of ascorbic acid as c.c. of N/100 iodine (1 c.c N/100 iodine = 0·88 mg. Vit. C), it is seen that the vitamin forms about 80% of the total activator present in fresh latex as estimated by iodine titration.

In presence of quinone-forming organic compounds,[6] ascorbic acid and peroxidase[7] can vigorously interact in certain biological oxidation-reduction systems.[8] The vitamin oxidized by the peroxidase can be reduced by glutathione[9]. Fig sap has been shown to be a rich source of peroxidase and hematin.[10] We have also observed a strong purpurin colour reaction[11] in the latex indicative of an active peroxidase system which is irreversibly destroyed by the addition of cyanide.

Evidently, apart from protecting the latex from spoilage, the cyanide also functions as an inhibitor of peroxidase activity in the latex and thus protects the vitamin from oxidation. The rôle of protecting the vitamins from oxidation is shared by thiol compounds and reducing agents. The direct relation of the vitamins to the milk clotting activity is still not clear, but the evidence obtained would clearly show that the factors which favour the stabilization of vitamin C are the same as those which help to preserve the milk clotting activity. A similar relation between rennin and ascorbic acid has been reported by Bhima Rao *et al.*[12]

C. R. KRISHNAMURTI
V. SUBRAHMANYAN

Department of Biochemistry,
Indian Institute of Science,
Bangalore,
30-10-1947.

[1] Krishnamurti *et al.* *J. Sc. & Ind. Res.*, 4, 720, 1946.
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[3] Hopkins and Morgan, *Biochem. J.*, 22, 1387, 1936.
[4] *Fleming*, *ibid.*, 16, 965, 1930
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[11] Wilstatter and Pollinger, *Ann-Chem. Pharm.* (Liebig) 269, 430, 1923.
[12] Bhima Rao, C. N., Lakshminarayan Rao, M. V., Ramaswamy, M. S. and Subrahmanyan, V., *Curr. Sci.*, 10 215, 1941.

VARIATION OF ELECTRONIC DENSITY IN THE IONOSPHERE WITH LATITUDE

CHAPMAN[1] has shown from the theory of ionization that during the equinoctical months, the intensity of ionization at the ionospheric layers declines as one moves away from the equator towards higher latitudes. Appleton[2] has recently shown with a large amount of ionospheric data recorded at various latitudes and longitudes during the war, that although the variation of ionic density with geographical latitudes agrees fairly well with Chapman's theory so far as the E and F_1 regions of the ionosphere are concerned, the same is however, not true for the F_2 region. He attributed the anomalies to the geomagnetic control of the F_2 region which gives rise to a belt of low ionization over the magnetic equator for noon equinoxes. A tentatise theory of the nature of the geomagnetic control was suggested by Mitra[3].

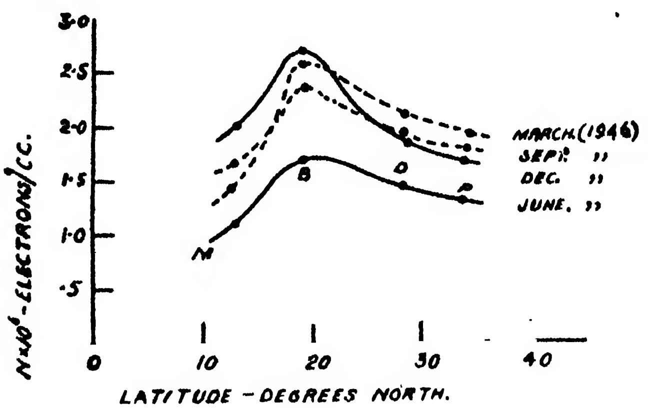

FIG. 1.

The purpose of the present communication is, firstly, to point out that recent monthly ionospheric observations recorded at the Indian latitudes, within a narrow range of longitudes, for more than one and half years, clearly shows that the noon electronic densities in the F_2 layer for stations nearer the equator are lower than for those at higher latitudes, and secondly, to show that part at least of the lowering of electron density may be attributed to increased temperature of the ionosphere over the equatorial region. Fig. 1 is a plot of the records of noon ionic densities at the Indian stations referred to above (P—Peshawar, *lat.* 34° 0′ N., D—Delhi, *lat.* 28° 35′ N., B—Bombay, *lat.* 19° 0′ N., and M—Madras, *lat.* 13° 0′ N.). The curves clearly show the waning of electron density from latitude about 20 degrees north towards the equator.

The reduction of electron density in an ionospheric region due to an increase in temperature can be easily calculated after Martyn and Pulley[4] assuming a parabolic distribution of density in the region of maximum ionization[5]. For a rough estimation, if the tempeature of 1000°K at the latitude of 20 degrees and that of 1200°K at the equator are assumed, then it is found that the electron density is reduced by about 40 per cent, due to the effect of temperature. This result together with the observed electron densities, as also electron density calculated from Chapman's theory are shown in fig. 2. Here BE shows the lowering of density due to enhanced temperature, curve PDBM is the plot of observed values and curve BC is the electron density variation after Chapman's theory.

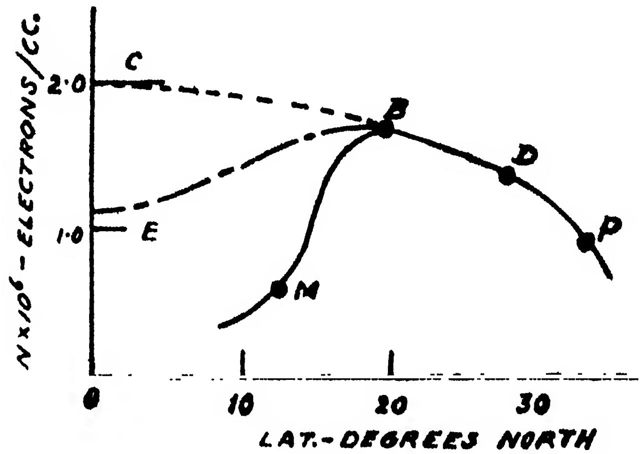

FIG. 2.

From the above it is clear that at least a part of the observed depression of electron density must be an effect of enhancement of temperature over the equatorial region. It will be noticed that the observed depression (curve BM, fig. 2) is much greater than the calculated one (curve BE). This is naturally attributable to the additional effect of geomagnetic control.

Further detailed analyses of the ionospheric observations are in progress and their results will be published later. Our thanks are due to the Research Department, All India Radio, Delhi, for supplying us the ionospheric data and to Principal M. Sengupta for his helpful interest in the work.

S. S. BANERJEE
R. N. SINGH

Section of Communication,
Engineering and Applied Physics,
Engineering College,
Benares Hindu University.
10-11-1947.

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2. E. V. Appleton, *Nature*, *157*, 691, 1946.
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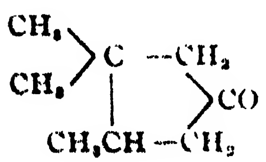
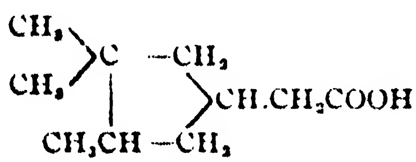
A SYNTHESIS OF 3:3:4 TRIMETHYL CYCLOPENTANONE AND A COMPLETE SYNTHESIS OF THE NAPHTHENIC ACID $C_{10}H_{18}O_2$

In the course of a series of interesting investigations[1] on the constituents of petroleum, J. von Braun isolated a naphthenic acid having the composition $C_9H_{17}.CO_2H$. The acid was converted in the usual manner into the corresponding primary amine $C_9H_{17}NH_2$, and the latter on exhaustive methylation followed by distillation of the derived quaternary base yielded an olefine $C_8H_{14}:CH_2$ which on ozonolysis afforded a saturated ketone $C_8H_{14}O$ (semicarbazone, m.p. 162-163°, di-p-nitrobenzylidene deriv. m.p. 188-190°). The ketoxime, $C_7H_{14}C:NOH$ which was obtained as a liquid, on reduction gave the corresponding amine $C_7H_{14}CHNH_2$ and the latter on exhaustive methylation and subsequent Hofmann degradation yielded isomeric unsaturated hydrocarbons having the composition C_8H_{14}, oxidized by $KMnO_4$ to a mixture of $\alpha\beta\beta-$, and $\alpha\alpha\beta$-trimethyl glutaric acids.

These experiments made it extremely probable that the C_8-ketone should be represented as 3:3:4-trimethylcyclopentanone (I), and consequently the naphthenic acid from which it is obtained on degradation must have the structure (II).



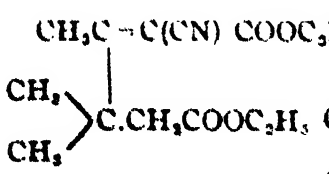
I



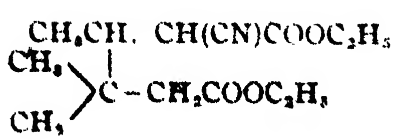
II

In conformity with this view von Braun and his co-workers were able to build up the naphthenic and (II) from the ketone (I) by the action of zinc and ethyl bromacetate (Reformatsky's reaction) followed by successive dehydration, reduction, and hydrolysis of the resultant product. All attempts[2] to synthesize the C_8-ketone, however, proved to be abortive.

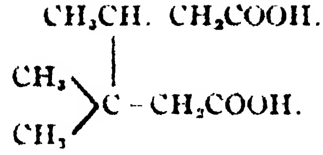
It has now been found feasible to prepare 3:3:4-trimethyl-pentanone synthetically and to convert the synthetic ketone into the naphthenic acid isolated from the natural sources. Briefly stated the synthesis is as follows :—



III



IV



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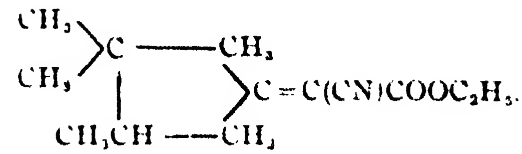
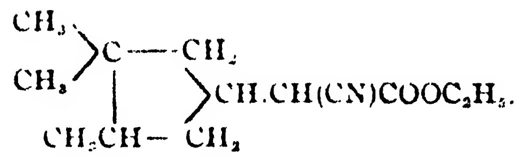


VI



VII

The chloride of the half ester of *as*-dimethylsuccinic acid was allowed to react with ethyl magnesiomalonate[3] and the resulting product on hydrolysis with hydrochloric acid gave a good yield of $\beta\beta$-dimethyl laevulic acid b.p. 150°/12 mm. The corresponding ethyl ester b.p. 94°/4 mm. was condensed with ethyl cyanoacetate in presence of ammonium acetate and acetic acid[4] and the *unsaturated cyano ester* (III), b.p. 156°/4 mm. thus obtained on reduction yielded *ethyl-α-cyano-ββ'β'-trimethyl adipate* (IV), b.p. 148°/4 mm. The latter on hydrolysis with conc. hydrochloric acid afforded *ββ'β'-trimethyl adipic* acid (V) as a crystalline solid, m.p. 103°. Catalytic distillation of the acid in presence of traces of baryta gave an excellent yield of 3:3:4-*trimethyl-cyclopentanone* (I) b.p. 174°/atm., which was further characterised by the preparation of a *semicarbazone*, m.p. 172°, and *di-p-nitrobenzylidene deriv.*, m.p. 190-191°. There can be little doubt that the synthetic ketone is identical with the product encountered by von Braun and his co-workers (*loc. cit.*). The synthetic ketone readily condensed with ethylcyanoacetate in presence of piperidine giving *ethyl* 3:3:4-*trimethyl-cyclopentylidene cyanoacetate* (VI) b.p. 154°/4 mm. and the latter on reduction gave the corresponding *saturated cyanoester* (VII) b.p. 146-148°/4 mm. which on hydrolysis in the usual way with conc. HCl furnished 3:3:4-*trimethylcyclopentyl acetic acid* (II) as a colourless oil b.p. 126-127°/4 mm. It was further characterized by the preparation of the crystalline amide m.p. 125° (von Braun and co-workers, *loc. cit.*). This is apparently the first complete synthesis of a naphthenic acid occurring in petroleum.

My sincere thanks are due to Prof. J. C. Bardhan for his kind guidance and interest throughout this investigation and for giving me facilities to work in his laboratories, and to the Principal, Bethune College, Calcutta for permission to work in my spare times in Prof. Bardhan's laboratories.

(Miss) DEBI MUKHERJI

Khaira Professor's Laboratories,
University College of Science and Technology,
92, Upper Circular Road,
Calcutta, 10-11-1947.

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[2] von Braun, Keller and Weissbach, *Annalen*, **490**, 186, 1931.
[3] Lund, *Ber.*, **67**, 938, 1934; also *Org. Syn.*, **17**, p. 86.
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ORDNANCE FACTORY

There are certain discrepancies and omissions regarding Defence Department in the article entitled National Research Council published in the October, 1947 issue of SCIENCE AND CULTURE.

The author has stated that "The M.G.O. (Master General of Ordnance) has a number of production factories and Testing Laboratories under his control." For correct information it can be said that the post of M.G.O. has been abolished from 1st April 1947. True it is that before the War the Ordnance Factories were under M.G.O. and consequently under Defence Department, but during the war all the Ordnance factories were brought under the department of Industries and Supplies. Since then the M.G.O. became the Head of the Inspectorate Branch (Inspectorate of Metal & Steel—I. of MSS., Chief Inspector of Military Explosives C. I. M. E., Kirkee, Inspectorate of Stores and Clothing, Cawnpore, etc.) and the Ordnance Factories were placed under the Director General of Munition Production, (D.G.M.P.) a post which was created under the Ministry of Industries and Supplies during the War. Later on, on the abolition of the post of D.G.M.P., Director General of Ordnance Factories, (D.G.O.F. which was also a war post) became Head of the Ordnance Factories. Towards the middle or end of February, 1947 these factories were again temporarily brought under M.G.O., but this was only for a brief span of time because the Directorate of M.G.O. Branch (including the factories and Inspectorates etc.) were abolished and passed to General Staff (GS) Branch from 1st April, 1947.

The accompanying chart will help to form an idea how the Ordnance Department is administered at present:—

Hon'ble Minister for Defence
Chief of General Staff (CGS)
Dy. Chief of General Staff (DCGS)

D. T. D. (Director of Technical Development)
- *Controller of Arms Development etc.*
- *Controller of Vehicles Development etc.*
- *Controllers of Stores Development etc.*

D. O. F. (Director of Ordnance Factories)
- *Superintendents of Ordnance Factories etc.*

As for omissions, about which I have mentioned in the beginning, I would like to point out again that list of production factories which the author has supplied is not a complete one. The outstanding omission is the non-inclusion of the name of an important factory as the Metal and Steel Factory at Ishapore. This is not only the biggest Ordnance Factory in India but is regarded as the parent or feeding factory. It regularly fed the different newly started ordnance factories in India with man power and materials.

LIST OF ORDNANCE FACTORIES IN INDIA

1.	Metal and Steel Factory ...	Ishapore.
2.	Rifle Factory	Ishapore.
3.	Gun & Shell Factory ...	Cossipore.
4.	Gun & Carriage Factory ...	Jubbelpur.
*5.	Harness & Saddlery Factory	Cawnpore & Cossipore.
6.	Clothing Factory	Shahjahanpur.
7.	Cordite Factory	Aravankadu (Nilgiri).
8.	Ordnance Factory	Muradnagar.
9.	Ordnance Factory	Katni.
10.	Ordnance Factory	Ambernath.
11.	Ammunition Factory ...	Kirkee.
12.	Mathematical Instrument Office (M.I.O.) now under Industries and Supplies	Dehradun.

The following factories, which were started during the war have been recently closed down:—

1.	Ordnance Factory	Khamaria.
2	Ordnance Factory	Lucknow.
3.	Ordnance Factory	Amritsar.
4.	Bren & Gun Factory ...	Hydrabad.

---

* There is no saddling or Harness Factory at Shahjahanpur. It should be "Harness and Saddlery Factory" at Cossipore and Cawnpore. Mathematical Instrument Office is at Dehradun and at present under the Department of Industries and Supplies.

INSPECTORATE BRANCH

1	Chief Superintendent of Development (Weapons)	Jubbelpur
2	Chief Superintendent of Ammunition	Kirkee.
3	Chief Superintendent of Instruments & Electronics	Dehradun.
4	Chief Inspector of Military Explosives	Kirkee.
5.	Inspector of Metal and Steel	Ishapore
6.	Superintendent of Proof and Experiment	Balasore

Regarding Laboratory, it can be said that the Laboratory of the Metal and Steel Factory, Ishapore, is one of the biggest laboratories in India. The amount of complicated works and various types of tests that are regularly done here, has placed it to the rank of a first rate laboratory in the country.

The author is correct in his remark that the "Veil of secrecy hangs very heavily in the Defence Service." But the veil is not too thick to pierce through. If a beneficial glance is cast round the Ordnance Factories the dearth of scientific personnel will not be so keenly felt. Many a scientific personnel are toiling and moiling in this department carrying out original works which are being published in distinguished journals in India and abroad. But they get no proper remuneration nor recognition even. If scopes and fields are provided to these persons they may prove themselves worthy of them.

One of the achievements of these scientific personnel may be mentioned here. During the War the Government of India felt the need of sufficient scientific technical men in the Ordnance Department. Consequently they started a Technical Training Centre at Ishapore under Metal and Steel Factory. In this centre hundreds of trainees were trained in different technical subjects with the help of a handful of scientific personnel. These trainees after finishing their course were sent to different newly started ordnance factories in India where they showed admirable skill in building up of these factories. Some of the metallurgical laboratories in these newly started laboratories are efficiently managed by these chemist trainees who had their training under my humble self. But due to the veil of secrecy the outsiders can never scent the very existence of these scientific personnel still working in the ordnance factories. But as the old days are gone, it is not too much to expect that the National Government as well as the leading scientists of the country should take some interest in the long neglected scientific personnel of the Ordnance Factories.

H. N. RAY

Metal and Steel Factory Laboratory,
Ishapore, Bengal.
18-11-1947.

CANNIZZARO REACTION BETWEEN FIBRE CELLULOSE OF JUTE AND CAUSTIC SODA

IN the method of Neale and Stringfellow[1] for the determination of acid value of cellulosic materials N/50 caustic soda is added in excess. Objections have been raised regarding the use of caustic soda on the ground that secondary reactions such as Canizzaro reaction occur between caustic soda and the aldehydic groups of fibre cellulose, whereby new carboxylic groups appear and vitiate the results. Though Cannizzaro reaction usually takes place in presence of concentrated potash,[2] the possibility of such a reaction cannot however be ruled out in the present case in view of the fact that aliphatic aldehydes which cannot undergo aldol condensation by virtue of their structure, have a strong tendency to give Cannizzaro reaction[3]; low concentration of the alkali may as well favour such a reaction.

In case the aldehyde groups in fibre cellulose undergo Cannizzaro reaction, the copper number of the material will appreciably fall after determination of acid value. This however is not the case as the following table will show.

Material	Copper Number* Before acid value determination	Copper Number* After acid value determination	Method of acid value determination
J-1347 defatted treated with N/10 HCl and washed acid-free	2·53	2·37	Sodium chloride and caustic soda
,,	,,	2·62	Silver orthonitrophenolate
,,	,,	2·22	Pot. iodide and iodate
J-1347—defatted treated with 1% NaOH, in the cold, soured with N/10 HCl and washed neutral	1·92	1·88	Sodium chloride and caustic soda
,,	,,	1·55	Silver orthonitrophenolate
,,	,,	1·60	Pot. iodide and iodate
Chlorite holocellulose from jute (J-1347)	1·94	1·68	Sodium chloride and caustic soda
,,	,,	1·46	Silver orthonitrophenolate
,,	,,	1·94	Pot. iodide and iodate

* Copper number was determined by Schwalbe-Braidy method. Means of duplicate or triplicate estimations are recorded above.

Then again, the acid value with sodium chloride and caustic soda should be significantly higher than that determined with silver ortho-nitro-phenolate or

potassium iodide and iodate if new carboxyl groups appear as a result of Cannizzaro reaction. This also is not a fact, more or less the same acid value being obtained by all the three methods.[4]

These observations therefore do not support the view regarding Cannizzaro reaction. It may be noted that only a slight excess of caustic soda has to be used in the case of jute fibre.[4]

P. B. SARKAR
A. K. MAZUMDAR
K. B. PAUL

Technological Research Laboratories,
Indian Central Jute Committee,
Tollygunge, Calcutta, 1-12-1947.

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2. Cannizzaro, *Ann.*, 88, 129, 1853.
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ON THE OCCURRENCE OF SCLEREIDES IN THE GENUS *OLEA* LINN

THE investigation of Sclereides in many genera and species of Oleaceae shows that these structures are typical and distinguishing features of this family. The matured leaves of six species of the Genus *Olea* namely *O. cuspidata* Wall., *O. dentata* Wall., *O. dioica* Roxb., *O. europaea* L., *O. glandulifera* Desf., and *O. polygama* Wight., were investigated with a view to study the morphology and development of the Sclereides within the leaves.

In mature leaves of *O. cuspidata*, *O. dioica*, *O. europaea*, *O. glandulifera* and *O. Polygama*, the sclerenchymatous fibres are nothing but transformed palisade cells running irregularly through the entire mesophyll penetrating as far as the upper and lower epidermis and spreading out beneath each as a regular layer (Fig. 1). They are cylindrical with a uniform width, occasionally branching with a few small branches as in *O. glandulifera*. In *O. europaea*, *O. polygama*, and *O. cuspidata*, the palisade cells develop branches which anastomose and form a reticulum. Often they run in close juxtaposition with the smaller veins in *O. glandulifera* and *O. cuspidata*. The mode of branching is very interesting. Firstly a split appears in the cell wall of the elongated sclereide, especially at the tip region; gradually lignin pushes out in the form of a small knob, over which the cell wall arches over to become a small plug, which on elongation becomes a small branch.

The developmental stages of the sclerenchymatous fibres studied in the species under investigation proved beyond any doubt that they are nothing but transformed palisade cells, with a good deal of power to elongate. These sclereides are hyaline with thick lignified walls, possessing a well marked lumen of uniform width.

FIG. 1. T. S. of leaf of *O. glandulifera* showing Sclereides within the leaf.

In the Genus *Olea* the sclerozed cells of the palisade tissue shows very varied types of differentiation. Based on the present study of sclereides in the Genus *Olea* four types of sclereides may be recognized.

1. Leaves with normal non-sclerozed palisade cells as seen in *O. dentata*.

2. Leaves with elongated sclerozed palisade cells running irregularly through the entire mesophyll penetrating as far as the upper and lower epidermis and spreading out as regular layers. These sclereides are :—

(*a*) flattened and anchor-shaped at either ends as in *O. dioica*.[2]

(*b*) cylindrical and having a few small branches at the ends as in *O. glandulifera* and *O. cuspidata*.

(c) profuse branching which anastomose to for a reticulum as recorded in *O. europaea*, *O. americana*, *O. angustifolia*, *O. chrysophylla*, *O. undulata* by Vesque and Pirotta (Boodle and Fritsch 1908).[3]

3. Spicular cells are also found in the mesophyll in *Olea Gardneri* and *Olea laurifolia* (Holtermann-Gerhard).

The presence of sclerozed palisades cell without the faculty of growth as reported in *Nyctanthes Arbortristis* Linn[1] has not yet been reported in the Genus *Olea*. It is interesting to examine all the species of the Genus *Olea* to find out whether there is any non-elongated sclerozed palisade cells which would become an intermediate stage between normal palisade cells as seen in *O. dentata* and highly elongated columnar sclerozed palisade cells as reported in the several species of the Genus *Olea*.

T. ANANDA RAO

Departmet of Botany,
Royal Institute of Science,
Bombay, 28-7-1947.

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[2] Krishnaswami, B. L., *Curr. Sci.*, *10*, 11, 1942.
[3] Solereder's Systematic Anatomy of the Dicotyledons translated by L. A. Boodle and F. F. Fritsch, Oxford University Press, 1908.

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APPLY.—Federal Public Service Commission, Simla before 24th January, 1948.

PATNA

ANCIENT—MEDIAEVAL—MODERN

AS the 35th session of the Indian Science Congress is being held at Patna, an attempt will be made in this short article to give our readers an outline of the history of this ancient city and of the unique part it played in the political, religious and cultural history of India. The history of Patna and that of Bihar dates back to the remotest period of ancient history. The patient researches of the archaeologists and historians have unearthed innumerable historical records from the mists of antiquity

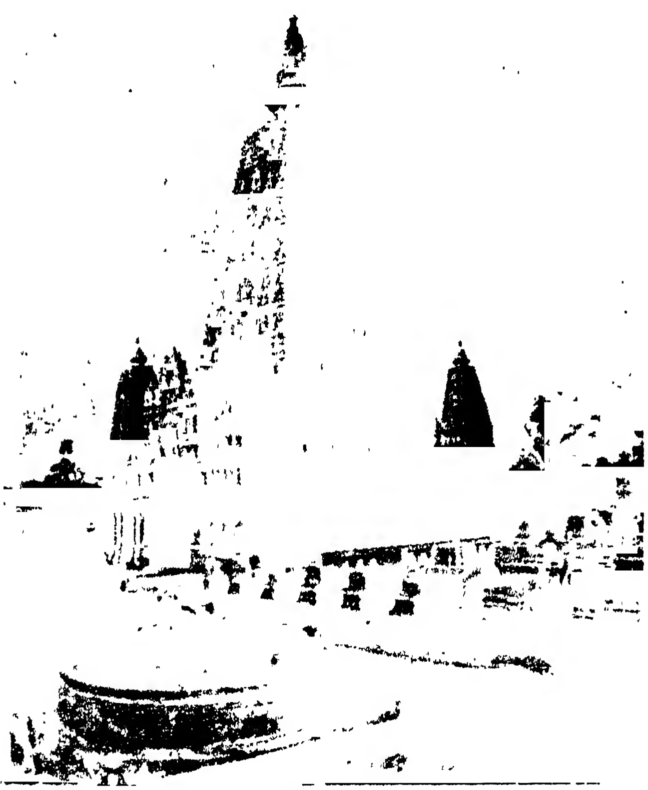

FIG. 1. Temple at Bodh Gaya Dt. Gaya, Bihar

The earliest capital of Bihar (Magadha) was at Girivraja or Vasumati which was founded by Vasu Chaidya-Uparichara, the father of Brihadratha, who established the earliest ruling dynasty of Magadha. Later on the capital was shifted to Rajagriha within the hills. Brihadratha was the father of Jarasandha of *Mahabharata* fame. Magadha was a centre of non-Aryan civilization for a long time and is referred to as *Kikata* in the *Rig Veda*. The *Kikatas* were a non-Aryan race who lived in the country which later came to be known as Magadha. At this time other powerful kingdoms flourished in the north and east, namely, Mithila or Videha in north Bihar and Anga, which, included parts of Monghyr and Bhagalpur districts of modern Bihar. The earliest republic in India of the Lichchavis also flourished in ancient times, north of the Ganges, with its capital at Vaisali.

The Brihadratha dynasty was succeeded by another dynasty in the 6th century B.C., one of whose rulers, Bimbisara, annexed Anga. Bimbisara is said to have been killed by his son Ajatasatru. Ajatasatru extended his territory by conquests. He defeated Prasenajit, the King of Kosala, married a Kosala princess and annexed Kasi. The expansionist policy of Magadha naturally led to a conflict between it and the powerful republic of Vaisali, situated on the opposite bank of the Ganges. Ajatasatru inflicted a crushing defeat on the Vaisalians and annexed their territory. He fortified the village of *Pataligrama* which was situated near the former confluence of the Ganges and the Sone, near modern Patna City, in order to repel the probable attack of the Lichchavis.

Udayibhadda, the son of Ajatasatru, transferred the capital to Pataliputra, probably to keep out of the aggression of Avanti.

Both Buddha and Mahavira lived in Magadha during the reign of Bimbisara and Ajatasatru. Mahavira attained *Nirvana* at Pava, modern Pawapuri, about 7 miles from the town of Bihar Sharif in the district of Patna. His remains have been enshrined in a beautiful temple in the midst of a tank. Gautama Buddha attained perfection at Bodh Gaya. He is said to have visited the new city of Pataliputra and remarked "Here Ananda, I see with divine and clear vision, surpassing that of men, gods in many thousands taking up their residence at Pataligrama. As far, O Ananda, as there are noble places of residence, as far as merchants travel, this will become the chief town, the Pataliputra, a centre for the interchange of all kinds of wares. Of Pataliputra, O Ananda, there will be three sources of danger, either from fire or from water, or from internal dissensions." This prophetic observation was fulfilled in a remarkable manner. The burnt wood discovered at Kumrahar, near the railway line between Patna Junction and Gulzarbagh, where the palace

of Chandragupta Maurya was situated, shows, according to some, that the palace was attacked by fire. A portion of the city was swallowed up by the river Sone and the city suffered greatly from internal dissensions after the death of Asoka and again in later times.

The history of Magadha is rather obscure and uneventful for many decades after Udayi till we come to the period of the Nanda kings. Pataliputra became the capital of a big empire and attained great prosperity during the Nanda period. Mahapadma Nanda, the founder of the Nanda dynasty, was the first paramount ruler of India. He brought a considerable part of Northern India up to the river Beas within his domain. The Hathigumpha inscription of Kharavela tells us of his conquest of Kalinga and several Mysore inscriptions indicate that the southern part of the Bombay Presidency and the northern part of Mysore were probably ruled by the Nandas.

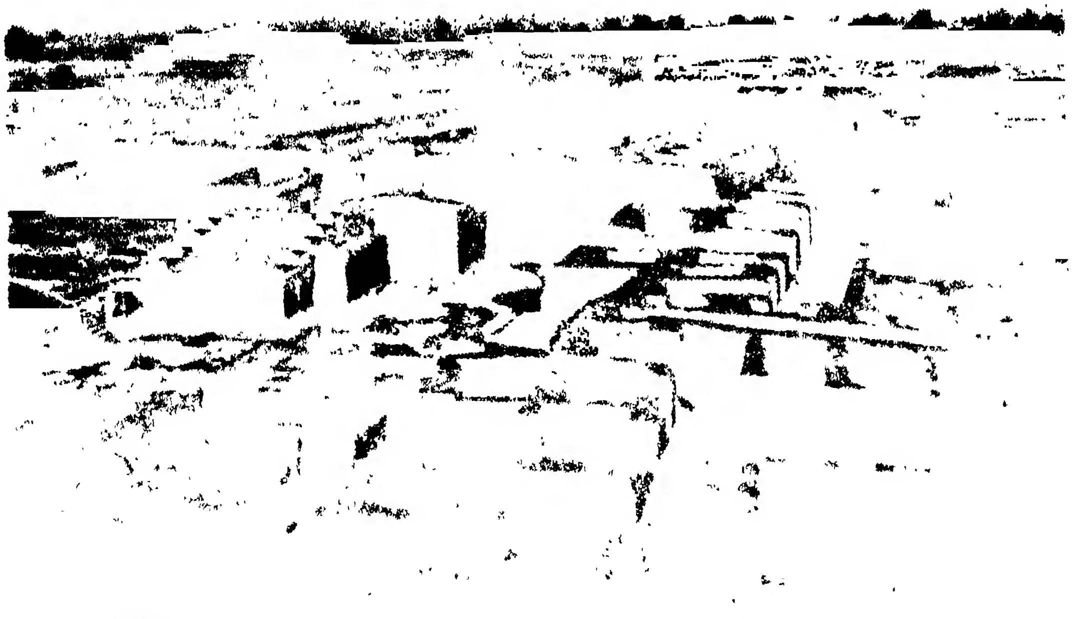

FIG. 2 Monastery at Nalanda, Dt Patna, Bihar

The Nanda dynasty was overthrown by Chandragupta Maurya, a scion of the Moriya clan of *Kshatriyas* of Pipphalivana, who had earlier liberated north-western India from the Greeks. Saleucus Nicator, the Greek ruler, failed to recover the lost territory and ceded the provinces to the south-east of the Hindu Kush. Pataliputra thus became the capital of a vast empire extending from the Hindu Kush to the Tinnevelly district in South India.

The reign of Asoka, the grandson of Chandr- gupta Maurya, was one of the most glorious epoch in the history of human civilization. During t earlier part of his reign he carried on the expansion policy of his forefathers, but the conquest of Kalin after a bloody war, proved a turning point in h career. He shunned violence and directed all his activities towards the amelioration of the social con ditions among his subjects and the growth of religion toleration among them. History does not recor another instance of a conqueror giving up the lu for power at the height of his glory and bend h energy to the spread of the gospel of peace, tolera tion and welfare of living beings among men. Prin Mahendra, son of Asoka, came to Pataliputra a Asoka's request and went to Ceylon carrying th message of Asoka. He became a monk later on and settled as a hermit probably at modern Bhiknapaha within Bankipur. Pataliputra became a great cent of cultural activities during the reign of Asoka. It was from here that his edicts and messages were sen out to the different parts of India and the adjacen countries. A great Buddhist Council was conven in this city by the Emperor.

The Maurya Empire began to decline after Asok and the last ruler of the dynasty was assassinate by his general Pushyamitra who founded the Sunga dynasty in about 186 B.C. Taking advantage of the weakness of the State, the Greeks invaded norther

...a but were defeated by the grandson of Pushya-...a on the right bank of the Indus. Art, religion ... literature flourished greatly during the Sunga ...od. The famous philosopher Patanjali lived ...ng this period. The Sunga dynasty was succeed-...by the Kanva dynasty.

The glory of Magadha was again revived with ... rise of the Guptas. The accession of Chandra ...pta I marks the beginning of the Gupta era from ... A.D. The power of Chandra Gupta seems to ...ve been consolidated by a matrimonial alliance ...h Kumaradevi, a Lichchavi princess. Pataliputra ...tinued to be the capital of India during the Gupta ...iod, in its early stage, but according to some ...thorities, it ceased to be the capital after the ex-...nsive conquests of Samudra Gupta, who, found ...odhya more suitable for the administration of his ... domain. According to others the capital was ...ifted from Pataliputra to Ujjain by Chandra ...upta II.

The Greek and Chinese visitors to India gave ...eat publicity to the importance of Pataliputra. ...rian wrote "The greatest city in India is that ...hich is called Palimbothra where the stream of ...ranoboas (Sone) and the Ganges unite—the Ganges ...ing the greatest of all rivers." It may be men-...oned that a diversion in the course of the Sone ...ad occurred about the period of the Muhammadan ...vasion. Fa Hien, the Chinese Buddhist pilgrim ...aveller, who visited India in the 5th century A.D. ...riting of the wooden wall by which the town was ...rrounded says "The city was the capital of King Asoka. The carving and the sculptures which ...rnament the windows are such as this age could not ...ake: they still actually exist." He makes the ...nteresting observation: "All the poor and destitute in the country orphans, widows, children, maimed people and cripples and all who are diseased go to these houses and are provided with every kind of help and doctors examine their diseases". Within two hundred years after the visit of Fa Hien the city fell into decadence and lay in ruins. The causes which led to its decay are not definitely known but a terrible earthquake near about 530 A.D. and the foreign invasion by the Huns were contributory factors. Hiuen Tsang writes (630-645 A.D.) of Pataliputra as follows "Pataliputra is an old city long deserted, now there only remain the old foundation walls. The monasteries, Hindu temples and Buddhist stupas which lie in ruin may be counted by hundreds and only two or three remain entire." Thus for over a thousand years Pataliputra occupied an unique position in the ancient world and, we shall see, how again and again it regained its importance.

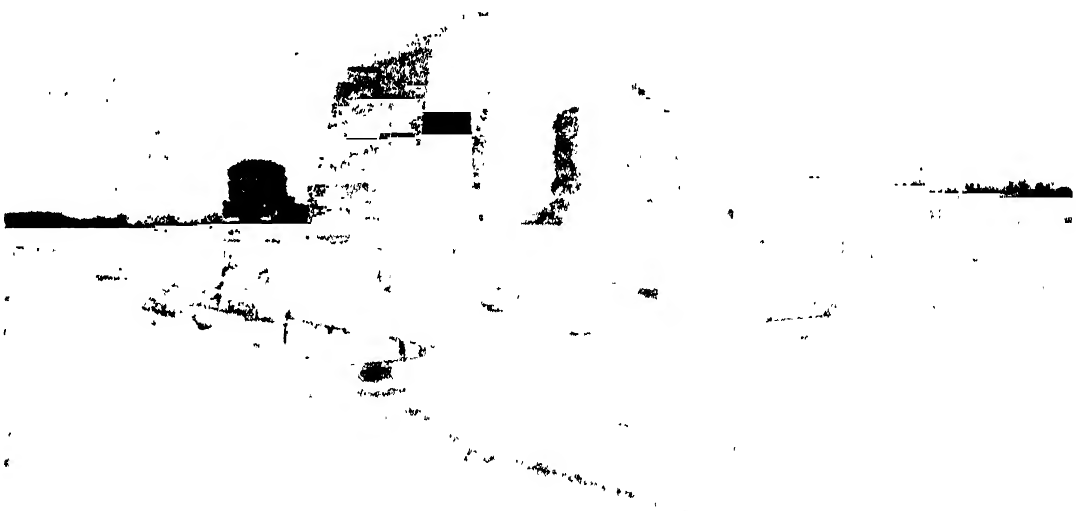

FIG. 3 Stupa at Nalanda. Repaired after Bihar Earthquake of 1934.

It was during the days of Asoka that a monastery was established at Nalanda which later became the most celebrated seat of Buddhist learning in the world. Hiuen Tsang gives a full description of Nalanda from which it may be surmized that the Nalanda University reached the height of its glory between 425 and 625 A.D. According to him the Nalanda University was founded by Sakraditya, who may be identified with Purugupta, who reigned in the earlier part of the 5th century. The University had richly ornamented beautiful buildings. Although founded by the Buddhists, the teaching imparted at this University was not at all sectarian but included all the branches of knowledge known to the ancient world. The priests and the pupils, both Indian and foreign, numbered about 10,000 and studied Buddhist literature and philosophy, the Vedas, Nyayasastra, medicine, Silpa shastra, Sankhya philosophy, etc.

The remains of Nalanda include the ruins of the great stupas, a range of Viharas and the original courtyard of the monasteries. According to Cunningham, some of the finest sculptures in India are found at this site. The site with its excavations and a museum are close to the Nalanda station on the Bakhtiarpur-Bihar Light Railway. The University was destroyed at the beginning of the 12th century when Muhammad Khilji, son of Bakhtivar Khilji, mistook it for a fort and attacked it, destroying its library.

In the first half of the 12th century, the Sen[illegible] in Bengal got rid of the Pala overlordship. The power of the Palas was crushed during the latt[illegible] part of the 12th century when they were attack[illegible] by the Senas from the east and the Gahadavalas [illegible] Kanauj from the west. Lakshmanasena defeated t[illegible] Gahadavalas but Bihar had no strong ruler to oppo[illegible] the incursions of Ikhtiyaruddin Muhammad [illegible] Bakhtivar. The Palas were great patrons of ar[illegible], literature and sculpture. The Nalanda Universit[illegible] also flourished during the Pala period and seve[illegible]

FIG. 4. Stone Temple at Nalanda

Pataliputra ceased to be the capital of India after the decline of the Gupta Empire. Harshavardhana of Thaneshwar annexed Magadh, and the other parts of Bihar formed several independent States. The later Guptas revived, to some extent, the kingdom of Magadha with its adjoining tracts, but in the first half of the 8th century both Bihar and Bengal came under the sway of Yosavarman of Kanauj who defeated the ruler of Magadha-Gauda (from East Bengal to the Vindhya Mountains).

The glory of Bihar and of Pataliputra was again restored under the Palas of Bengal who were the last Imperial rulers with their capital at Patna. During the Pala dynasty Bihar again played a prominent role in the history of India and was linked up with Bengal. The Pala emperors had to fight with the Pratiharas of Kanauj and the Rashtrakutas of the Deccan. When the Pala rule became weak at the beginning of the 10th century, the Pratiharas occupied the whole of north Bihar and north Bengal and the Gaya and Hazaribagh districts. Again when the Pratiharas were defeated by the Rashtrakutas, the Palas regained control over the Gaya, Patna and Muzaffarpur districts of Bihar and probably also over Tirhut.

other monasteries and seats of learning were esta[illegible]blished by the Palas. Dharmapala is believed to hav[illegible] founded the monasteries of Vikramsila and Oddanda[illegible]puri. There is controversy about the sites but man[illegible] believe that Oddandapuri was at modern Bihar. There were famous sculptors, named Dhiman an[illegible] Vitapal, who were brothers, in the court of Dharma[illegible]pala. Innumerable figures of gods and goddesse[illegible] executed in the most beautiful style have been foun[illegible] in numerous villages of Bengal and Bihar.

Patna again rose into importance towards th[illegible] middle of the 16th century when Sher Shah made i[illegible] his capital. On his way back from Bengal, he passe[illegible] through Patna where he is said to have decided to build a fort on the bank of the Ganges. A fort wa[illegible] built in 1541 from which date it again became the capital of an independent State which was finall[illegible] annexed by Akbar himself in 1574. The English traveller Ralph Fitch visited Patna in 1586 and described it as an important market for cotton, textiles, sugar, opium, etc., but in the *Ain-i-Akbar[illegible]* of Abul Fazl, written ten years later, Patna does not appear to have been a big city at that time. In 1621, Jehangir appointed his son Parwez, Governor of Bihar and thereby started the practice of appointing

...l princes as provincial governors. Parwez built ... Patharki Masjid at Patna and the Palezaghat ...posite Patna on the other side of the Ganges is ...bably named after him. When Shah Jehan re...lted against his father he forced the surrender of ... fort of Patna from the representative of Purwez. ...ring the reign of Shah Jehan and Aurangzeb, ... city enjoyed peace and prosperity. Tavernier ...tes that Patna was the most famous market in ...thern India in the middle of the 17th century. H... found here not only Portuguese merchants but ... traders from Poland. The Dutch traders had ... establishment here for trade in saltpetre which they ...ned at Chapra. When Azim-us-Shan, a grand... of Emperor Aurangzeb came to Patna as ...vernor, he changed the name of the city to Azima...d in 1704 with the Emperor's approval.

source of sugar and saltpetre, which was then in great demand for the manufacture of gun powder. In 1651, the East India Company set up a factory at Hughly and a trading agency at Patna. They established a factory on a permanent footing in 1675. Earlier the Dutch had established a factory and the present main building of Patna College was also built by the Dutch. The English improved their position under the able guidance of Job Charnock (1664-80). The old English factory above the river at Gulzarbagh now belongs to the Government Press. It was here that the Emperor Shah Alam II was recognized as the Emperor of India by the English. The French settled down about 1720.

After the Battle of Plassey in 1757, when Mir Jafar became the Governor of Bengal, several Rajas and Zeminders and the Deputy Governor of Bihar

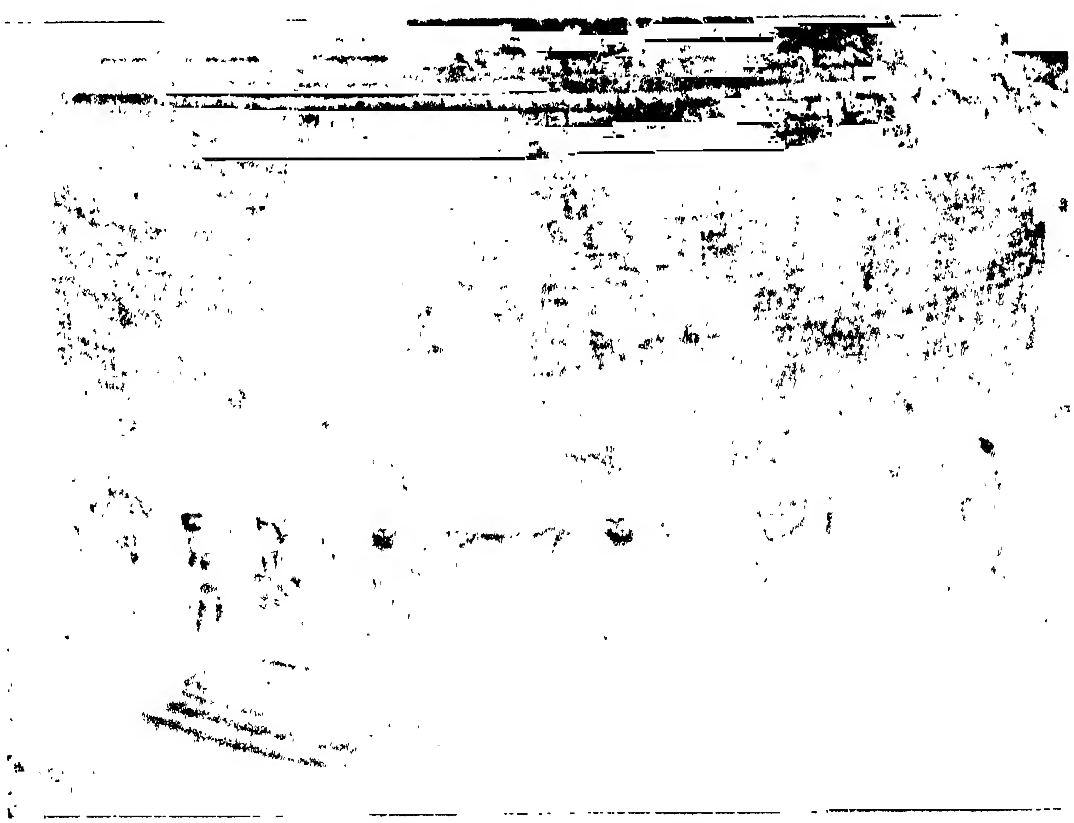

FIG. 5. Stucco figure on base of a temple at Rajgir, Dt. Patna, Bihar

Bihar again came to be joined to the Subah of Bengal during the period of the break up of the Mughal Empire. Bengal had earlier become practically independent of Delhi under Murshid Quli Jafar Khan who was Governor of Bengal from 1703-27.

In the 17th century, Patna had a flourishing trade in cotton and silk goods. In 1620, the first English commercial mission visited Patna to explore the possibility of purchasing Bengal silk and calicoes of Patna. In the middle of the 17th century Patna became well-known to the European world as a

opposed Mir Jafar. They were assisted by the French. Clive himself came to Patna along with Mir Jafar and suppressed the opposition. The Nawab granted the Company the monopoly of saltpetre trade. Ali Gauhar, son of Emperor Alamgir II, invaded Bihar in 1759. He besieged Patna and and was assisted by the French. He was driven out but came twice after this after assuming the title of Shah Alam. Shah Alam was finally defeated in 1761 at a place six miles west of Bihar town. He came to terms with the English and, as has been said

before, recognized as the Emperor. There were troubles between Mir Kasim, the new Nawab, and the English. The Nawab's troops were defeated in several battles. Mir Kasim then formed an alliance with Emperor Shah Alam and Nawab Sujah-ud-Dowla of Oudh. In 1764, they invaded Bihar but were defeated by Mir Jafar, who had been reinstated Nawab, and the English at the battle of Patna. On the 23rd of October, they were finally defeated at the battle of Buxar, after which the Emperor granted the Company the Dewani of Bengal and Bihar. Bihar remained united to Bengal once more from this date till the separate province of Bihar and Orissa was created in 1913 with its capital at Patna.

The formation of Bihar and Orissa as a separate province was proclaimed in the Delhi Durbar, 12th December, 1911. The milestones in the growth of the province and its capital Patna, can be indicated by the selection of Patna as the venue of the Indian National Congress in 1912, All India Oriental Conference, 1931, Indian Science Congress, 1933 and the Indian History Congress, 1946, and the establishment of the Patna University in 1917, Patna High Court, Government House, Provincial Secretariat and the Patna Museum. Like other capitals of Indian provinces, Patna has also made considerable progress in the fostering of education in all branches of science and arts. The sites of the local colleges—the Patna College, opened on the 9th January, 1863, the Bihar National College, 1889, the Bihar College of Engineering, 1896, Patna Law College, 1909, P. W. Medical College, 1927, Patna Science College, 1928, Patna Women's College, 1940 and the Government Degree College for Women—on the banks of the Ganges and all in a line, remind us of the Pataliputra, which was a seat of learning, almost equal in reputation to that earned by the Nalanda, Taksasila, Odandapuri or the Vikramasila monastery, and where the students of the *asramas* of Panini and Vyadi were having their lessons in grammar and logic. Besides these institutions, other colleges and libraries are the Patna Training College, Bihar Veterinary College, Patna School of Art, Patna Blind School, Deaf and Dumb School, Government Ayurvedic School, Government Tibbi School, Khuda Baksh Oriental Public Library, Bihar Research Society, Patna University Library, Sinha Library, Bihar Youngmen's Institute etc.

Within three decades between 1911 and 1941 there has not only been an appreciable improvement in the amenities of life, varieties of institutions, trading activity, opening of banks, aerodrome, the birth of the New Capital for the employees of the Bihar Secretariat, but also in a phenomenal growth of the population of Bihar. In 1911 the population of Bihar was 29,347,372 and in 1941 it rose to 36,340,151. That Patna of the days of F. Buchanan which contained only 52,000 houses, has now been faced with a problem of shortage of houses even after the construction of more than a million. The Government of Bihar has been sponsoring plans of a Greater Patna. On its northern side, the Bihar Government is proposing to the Government of India, the construction of a bridge across the Ganges at Patna instead of Mokameh. On the southern side the city may extend upto Kumrahar, where prefabricated houses may be constructed, reminding us of the huge timber palisades of the capital of the Mauryas, and its inhabitants. Let us hope to uphold the ideal symbolized by the Wheel, which is placed at the centre of the flag of the Indian Union.

S. C. Chatterji

[1] The author acknowledges with gratitude the help he has received from Prof. T. P. Bhattacharya and Prof. B. P. Mazumdar of the Bihar National College in the preparation of the article.

[2] Our thanks are due to the Director General, Archaeological Survey of India, Government of India, for permission to use the photographs for illustrating this article. (Ed. *Sci. & Cul.*)

Rationalisation of Medicine in India

Sir Ram Nath Chopra's General Presidential Address at the Indian Science Congress, Patna

INTRODUCTION

THE highest honour which a scientist in this country can aspire to, is to be elected the President the Indian Science Congress, and I wish to express my deep sense of gratitude to you for this distinction. On looking back at the brilliant array my predecessors great scientists, distinguished industrialists, and eminent statesmen, I am also made conscious of the great responsibility which the election to this office entails. On receiving the news my election, I wondered whether I would be able to do justice to the task assigned to me. I accepted with great humility and with doubts of my ability succeed worthily that great statesman and foremost national leader, Prime Minister Pandit Jawaharlal Nehru. I was, however, encouraged by the thought that in carrying out my duties, I shall have the full support and collaboration of the body of eminent scientists and others associated with this great organisation.

The venue of the congress in Patna is of personal interest to me. It was during 1929-30 that the Patna University invited me to deliver a course of lectures in connection with the recently founded Sukhraj Ray Readership in Natural Science. As at that time, I was engaged in the study of the rationalization of the use of the materia medica of Indigenous Medicine, I selected it as the subject of my lectures. To-day, in my address on the *Rationalisation of Medicine in India* I propose briefly to review the work done since and to indicate how this study is likely to help in replacing the empiricism current in medical practice by a system based on scientific research and verification, *i.e.*, a rational system.

INDIGENOUS MEDICINE

Zenith of Development.—The development of medical science in India is a fascinating study. The ancient Hindu System of medicine has not only provided relief for the past many centuries, but is still doing so to large section of our people over vast areas of this great country. Ayurveda, which is stated to have been written about 2,000 years B.C., formed the foundation stone of medicine in India. Later on such works as Charaka and Susruta, and many others dealing with such subjects as anatomy, medicine, surgery, gynaecology and obstetrics, made their appearance. The human body was dissected and attempts were made to understand the functions of important organs. A close study of the literature of that period reveals the strength and extent of scientific knowledge of ancient India regarding the diagnosis and treatment of the diseases then prevalent. Early records indicate that the immunity to small-pox conferred by cow-pox was known in that age. The therapeutic agents used were both of organic and inorganic origin. It has been shown that even anaesthetics, administered both by the mouth and by inhalation into the lungs, were used for surgical operations in the early part of the Christian era. Particular attention was paid to dietetics, and dietary was carefully worked out with due regard to individual susceptibilities and according to variations in times and seasons of the year. About this time, Hindu Medicine had attained its highest development and there is evidence to show that it permeated far and wide into Egypt, Greece and Rome, and played an important part in moulding both Greek and Roman medicine, and through the former the Arabic system.

Decay.—As invariably happens, decay set in with the passage of time, and during the first millennium of the Christian era Hindu medicine became not only sterile but waned and declined in its standard of efficiency. When the Muslims invaded India, they brought their own healing system; this gradually gained ground in the country and became the State System of medical relief. Muslim medicine had been greatly influenced by Greek medicine, as it reflected in the name Unani (Greek) by which it is generally known in this country. It brought with it rich stores of materia medica derived both from the Arabian and the Greek sources hitherto unknown in this country. The Arabs also had made great advances in the domain of chemistry, and their materia medica had as its basis the generally accepted scientific doctrines of that period.

In its turn, with the decline of Mohammedan rule in India, Muslim medicine also suffered a set

back and made way for the Western System of medicinal relief, which was introduced by the advent of the Europeans. The new European system gradually found its way to the people, and appreciation and demand for it extended universally all over the country. Particularly this was due to its surgical achievements ; at the same time its more systematized and standardized materia medica supplanted to a great extent the heterogenous indigenous drugs in use.

In the evolution of practice of rational medicine in this country, we have, therefore, to consider the effects produced by the impact of all these factors.

Present Position. What is the present position of indigenous medicine from the utilitarian and scientific aspects? It is generally believed that Ayurvedic medicine had remained sterile for many centuries. During this period, much of the old literature was either mutilated or lost, and degeneration set in in all its various branches, particularly in surgery, gynaecology, etc. The practice of medicine was restricted at first to the Priestly Class and then to certain sub-castes, who on one side believed that as the Ayurveda was an inspired science, it was not possible to improve on it further by the wisdom of man. On the other hand the touching of dead body was regarded as polluting and, therefore, sinful, and the dissection of bodies was given up, the result was that studies of such basic subjects as Anatomy and Physiology were altogether neglected. The effect of ignoring these basic studies particularly on surgery can well be imagined. A large number of drugs were, however, introduced during the late Buddhist period and properly equipped hospitals and a well-organized system of State medical relief was instituted. But with the decline of Buddhism deterioration set in all round in knowledge, teaching and practice of medicine. Not only was information regarding many drugs lost, but recognition and identification of a large number became impossible. This was a great loss to Ayurvedic medicine, and whilst there undoubtedly is reason to be proud of its glorious past, it is not possible to view its present condition without a sense of apprehension.

It has been my good fortune to come into contact with eminent scholars and practitioners of Indigenous Medicine, some of whom have also studied the Western Medicine. They are equally concerned with the decline and sterility of the system but consider that as there is much in common between the old and new ideas concerning the etiology, pathogenesis and treatment of disease, the restoration and development of the Indigenous system would not be difficult. The old theories of causation of disease according to them can be justified in the light of recent advances in scientific medicine. Some even claim that there are indications that the old Hindu medicine had knowledge of the bacterial origin of disease, and that even the role of viruses was not unknown. They point out that in their system more attention has rightly been given to the state of the soil, that is, the body, than to the seed of disease, that is, the micro-organisms which become engrafted on it. In recognizing the importance of this soil factor, which has now been appreciated by Modern Medicine, Indian Medicine was undoubtedly centuries in advance of the Western. The eminent scholars and practitioners of Indigenous Medicine, however, realise fully the need for investigation and research, if their system of medicine is to be brought into line with the present day requirements. For with the lapse of time and changes in environments some diseases have become modified and perhaps their aetiology and pathology altered. While some of the old diseases have disappeared new ones have come in. The great advance recently made in treatment too cannot be neglected. Unless fresh knowledge is acquired, their practice would be at a grave disadvantage. Unfortunately, very little has been done so far in this direction. Many among the orthodox Vaidas still believe in the divine origin of Ayurveda and resent the introduction of any innovations. They have resisted all attempts at the inclusion of new ideas and even of considering the possibility of any improvements in the practice of their ancient system.

The position with regard to Tibbi medicine, both as regards its theory and practice, is no better than that of the Ayurvedic medicine. What has been said about the present day status of Ayurvedic medicine applies with equal force to the literature and practice of Tibbi medicine.

That there is much in the Indigenous Medicine, especially in its materia medica, which can contribute to the well-being of the people of this country, is beyond any doubt. Eminent Western scholars and the medical men have borne testimony to their efficacy and usefulness. But with such a background as has been described above, Indigenous Medicine, it is believed, cannot play as effective a part nor take its proper place in the present day medical relief in this country, as its exponents would claim, and the people would rightly expect them to do. They will first have to put their house in order and become cognisant of the present-day environments and their requirements. The practitioners will have to be properly trained, and unauthorised practice will have to be rigidly eliminated. The true spirit of research and discovery will have to be inculcated and irrationalism excluded from diagnosis and treatment of disease. The discoveries which have proved effective beyond doubt in the treatment of disease

must be accepted and incorporated, and all inherent prejudices discarded to achieve the one sublime object of the alleviation of human suffering.

Medical Relief to the Masses

Mode of Relief.—At the present time in this vast country, medical relief to the masses is carried out by two agencies—(1) Indigenous and (2) Western :—

(1) Indigenous Medicine is being practised by a vast number of practitioners. Unfortunately only a small portion of these have received any proper systematic training in educational institutions set up for the purpose. Of the rest a few may have acquired some knowledge through connection with families which have either practised this art for generations or through having sold medicines. By far the largest number, however, have received no training whatsoever. Most of them collect an assortment of medicines and sell these to the ignorant and credulous masses. Many of them are wandering pedlars who carry their stock-in-trade of medicines with them from place to place. Their nostrums have the virtue of cheapness no doubt, but they cost the people very dear indeed. There is evidence to prove that they are responsible for producing much misery and suffering. But it is this very class which at the present time attends to the needs of the major portion of the population, particularly in the rural areas which are so inadequately supplied by properly trained practitioners of any system. There are however, some important considerations in favour of the Indigenous Medicine if it is properly practised. The first is that the materia medica used is derived entirely from indigenous sources, and therefore, is inexpensive and suits the people whose economic condition is low. The second is that these systems are ingrained among the people who have faith in the treatments prescribed and the drugs used. Some even consider that it suits their constitution better.

(2) The second agency of medical relief is through practitioners of Western Medicine. This system of medicine has been in vogue in India for nearly a century and a half, and is the form of relief recognised by the State. Though it has a scientific basis and is, therefore, much more amenable to rational practice, it unfortunately does not reach much more than 20 per cent of the population of this vast country in spite of all efforts that have been and are being made to extend it.

The reason for this tardiness is not far to seek. The economic condition of masses of the people is very low and there are millions who cannot afford any kind of treatment whatsoever, cheap or expensive. Consequently, they have to depend on charitable medical relief institutions which, considering the extent of the population, are not only too few in number but are so suited as to be available only for limited areas of the country roundabout. The cost of medicaments is so high that most of these institutions with limited annual budgets, are not able to cope with the demand for common essential drugs, to say nothing of the expensive medicines which are sometimes necessary and are even indispensible. For these reasons, but chiefly on account of its costliness, the practical utility of Western Medicine for medical relief on a very large scale has been limited.

In any scheme of rationalisation and extension of medical relief to the masses, all these factors will have to be carefully considered without prejudice for or against any particular system - medical relief on rational lines and on as extensive a scale as possible being the prime and only consideration.

Irrational Practice of Modern Medicine.—Quite in contrast to the Indigenous Medicine, Western Medicine has made enormous strides, both in connection with the causation of disease and its treatment. This is not the place for me to go into details of the progress which has been made during recent years, but its effect in relieving human suffering has been remarkable. So far as the application of these discoveries in actual diagnosis and treatment of disease among the teeming millions of this country is concerned, it must be admitted that the general practitioner has lagged far behind the times, in his knowledge and equipment. This position is unsatisfactory and regrettable. It has been my painful duty to point out, from time to time, the tendency of practitioners of Western Medicine towards mere empiricism. The remarkable progress in the aetiology, physiology and pathogenesis appears to lose its significance, and makes little appeal to them in the actual practice of the healing art. Diagnosis is still made on empirical basis in the majority of cases. Non-critical and irrational use of therapeutic agents is rather the rule than the exception. In part this is due to the fact that medicine is mostly taught through European and American text books and is practised without making due allowances for climatic and other environmental factors. The ideas regarding diet in disease run counter to the beliefs held by people and are often repugnant to their social and religious susceptibilities. In fact if the state of medical practice in India is examined without prejudice, one is forced to the conclusion that with the exception perhaps of a small number of institutions, such as large hospitals and colleges and of a comparatively small number of practitioners, the practice of Western Medicine is not even a shade better than that of Indigenous Medicine. And one

dare not estimate the harm that has been done through indiscriminate use of powerful remedies which science has placed in the hands of the practitioners.

In addition the outlook of the average Western medical practitioner of the present day is sadly restricted. While he is always crying down indigenous medicine, he takes no steps to improve the low standard of his own practice. The charge of irrationalism applies as much to him as to the practitioner of indigenous medicine. Pandit Jawahar Lal Nehru, while inaugurating the meeting of the Conference of Physicians last year, criticised the spirit of narrow trade unionism which dominated the medical profession in India. He exhorted the practitioners to keep in view the interests of the community as a whole and to help in building up a healthier and more prosperous India. This call was truly needed for public health is perhaps the most important item in the programme of a nation and yet its promotion is badly neglected by the medical profession in this country. It is a sad commentary on things that though Western medical science has been well established in the whole country for at least half a century, if not more, it has not yet succeeded in making the average educated men more health conscious, to say nothing of the uneducated and ignorant masses. Again, there is very little understanding between the medical man and the patient. The doctor often looks down upon the poor class of patients and does not accord them the sympathy and consideration which is their right. This is particularly the case in government and semi-government institutions. The resentment often expressed in press and elsewhere, bears ample testimony to this fact, and most of us are aware of it from personal observation also.

These are some of the potent reasons why an average Indian shuns the Western medical practitioner and prefers the more sympathetic and considerate Vaid or Hakim. How can rationalisation be achieved under such conditions? I say without the least hesitation, from my personal experience during the last forty years that I have discerned little progress in the rationalisation of practice of Western medicine generally in this country. But while I say this, I must also admit that the blame does not lie wholly at the door of the general practitioner.

Why Rational Medicine not Practised

Financial Starvation.—One of the chief reasons why rational medicine has not been practised, is that those responsible for the Government of this country in the past have neglected the growth of the nation building health services. The *per capita* expenditure has, in the past, been absurdly low as compared with that what should have been spent. The Bhore Committee on Health Survey and Development has pointed out that even after making due allowance for the much higher national incomes in countries like Great Britain and the United States "India should have spent annually Rs. 3/3/- per head of the population if her expenditure on health services were to bear the same relation to the national income as the amount spent in Great Britain in 1934-35 on health measures bore to her own national income. On the basis of a similar comparison with the United States, India's *per capita* expenditure on health, should have been Rs. 2/5/-." In comparison with these figures the combined expenditure on medical relief and public health activities in the provinces during 1944-45, ranged between 2·8 annas *per capita* in the Central Provinces to 10·9 annas in Bombay. Is it, therefore, surprising that medical education and medical research which form the foundation of rational medicine have suffered seriously? The teaching institutions are too few and many of those that exist are poorly equipped and inadequately staffed. The teaching of such important subjects as physiology and pharmacology the science of action of drugs, on which mainly depends the progress of medical treatment, is highly defective. Others such as pathology and bacteriology are no better. Practical instruction in most subjects leaves much to be desired. Hospitals and dispensaries are few and far between, and lack modern facilities and appliances, and the number of practitioners is far below that required for adequate relief.

Medical Education. Medical education should, therefore, be carried out on much broader and sounder lines than heretofore if the present low standard of medicine in India is to be raised. This can only be done by improving the educational institutions, both as regards their teaching staff and equipment. No doubt, this will mean enormous expenditure, but it is expenditure that will repay itself many times.

The system of letting all the clinical teachers indulge in private practice has led to much abuse and neglect of their teaching duties. Such practice in State-supported hospitals has given rise to most reprehensible differential treatment of patients. While it is desirable that a few of the senior teachers may take up private practice and bring the experience from that particular type of practice to the student, its indiscriminate indulgence by all teachers has done incalculable harm to medical education.

Then, large sums of money are being spent at present on students going to foreign countries for obtaining qualifying medical degrees. If our own

educational institutions were improved this drain would stop. Facilities for post-graduate studies should be very considerably increased and medical graduates encouraged to take these courses frequently. This can best be done by sending selected teachers to progressive countries to receive advanced knowledge and after their return to disseminate it among the medical profession. Provision should also be made for sending abroad qualified individuals for training in specialised subjects so that this knowledge is brought to the post-graduate students. Exchange of lecturers and professors should be arranged with well-known institutions all over the world. With the object of training our own men in special lines experts in highly specialised subjects should be imported, for limited periods, into Universities and Colleges, irrespective of the cost.

Group Practice.—It is obvious that modern medicine cannot be practised scientifically and rationally unless the necessary expert personnel and facilities for diagnosis and treatment are available. Both these are sadly lacking at present even in large towns. During recent years the development of 'group practice,' that is, collaboration of specialists in different branches with all their resources in the diagnosis and treatment of disease, has become a very noticeable feature in America and in Great Britain. In the latter country, the proposed National Health Service will bring into being the health-centre, an istitution which it is intended should provide the general practitioner with all modern methods of diagnosis and treatment. If the medical practice in this country is to be rationalised, adequate provision will have to be made on similar lines. A beginning on these lines was successfully made in the School of Tropical Medicine, Calcutta, some years ago.

Medical Research.—There is no doubt that rational medicine cannot be practised unless there is extensive medical research. Here again one is struck with amazement at the callousness and apathy of the Government of this country in the past, at the manner in which medical research was relegated to the background. The annual grant for medical research by the Government of India, till recent years, was only a paltry few lacs of rupees and even this was cut down through the disgraceful recommendations of the Inchcape Commission. The research worker is poorly paid and all the best talent goes to practice because it is more remunerative. You have only to see what importance countries like the U.S.A. and Great Britain, are attaching to medical research and the amounts they are spending for this purpose, to realise the importance of medical research in rationalisation of medicine. With all these disabilities it is not surprising that the standard of medical practice in India is low, and scientific or rational medicine has not been practised.

The immediate implementing of a progressive plan like the one put froward by the Bhore Committee will enable us to draw abreast of recent knowledge and to introduce in our country up-to-date teaching and research and what is best in the health administration of advanced countries. Medical education, post-graduate studies and medical research will thus be brought to the level in the progressive countries. This will mean that the expenditure on health measures which has hitherto been in the neighbourhood of the absurdly low figure of about 6 annas *per capita* per annum, will be increased to 2·5 rupees a year. Even when this has been done India would be spending on public health only 15 per cent of her national income (Central and Provincial) as compared to the 25 per cent spent by Great Britain. But increased expenditure is the only method which will eventually give the country an up-to-date health organisation and medical relief on scientific basis.

Trained Personnel and their Retiring Age.—Trained personnel is the first and foremost important single factor for provision of adequate medical relief on rational lines. India possesses not more than 40,000 trained medical men and this works out about one doctor for 10,000 of population. Even this proportion does not give a correct idea because most of this personnel is concentrated in large towns. Look at it any way you like, the present number available is entirely inadequate. For adequate relief necessary for rationalization there should be at least one medical man per 1,000 of the population. In fact in advanced countries there are two or three per 1,000. Thus we need at least ten times the number we have and it will take at least 30 to 40 years to train sufficient men for our need. It is imperative, therefore, that we do make the most of what we have. The present retiring age in regular services and elsewhere is considered to be 55 years when most of the incumbents are yet fit to carry on efficiently for many years. They should be made to work as long as possible and, if necessary, their sphere of work should be changed to suit their physical capacity.

When we come to highly specialised workers, such as Research Workers, of whom we have a still less adequate number, it would be foolish to retire them as is the usual practice at the age when they are most valuable for training other workers, organising new institutions and directing the activities of younger workers.

The retiring age of 55, which is now treated in the country as an unalterable law, was fixed by a foreign Government for Imperial Services staffed

largely by foreign workers. They wanted them to go back Home, live in comfort or carry on efficient work for many years at our expense. What I am saying about medical workers applies with equal force to other scientific and technical personnel. There is no other country in the world where other than manual workers are retired earlier than 65 years.

The Role of Indigenous Medicine

Bhore Committee.—The Bhore Committee considered in detail various aspects of public health and medical relief, but left the part played by indigenous medicine severely alone. It was stated that the Committee was not in a position to assess the real value of indigenous medicine as practised to-day. They stressed, however, that certain aspects of health problems could be secured wholly or at any rate largely, only through up-to-date scientific medicine and that indigenous medicine could not give much help here, as preventive medicine or public health was its weakest feature at the present time. The Indigenous Medicine does not also, at present, deal with such vital aspects of medicine as obstetrics, gynaecology, advanced surgery and other highly specialised subjects. Further, no system of medicine which is static in conception and practice and does not keep pace with the discoveries and researches of scientific workers the world over, can ever hope to give the best ministration to those who need its aid. The Committee, therefore, recommended that "it should be left to the Provincial Governments to decide what part, if any, should be played by the Indigenous Systems in the organisation of public health and medical relief. It is for them to consider, after such investigations as may be found necessary, under what conditions the practice of these systems should be permitted and whether it is necessary, either during some interim period or as a permanent measure, to utilise them in their schemes of medical relief." The criticism offered is very cogent and awaits an answer by the exponents of Indigenous Medicine.

The scheme envisaged by the Bhore Committee, admirable as it is, is bound by its very nature to take a considerable time to mature. The question, therefore, is whether things should be allowed to drift as they are drifting while a perfect system is being evolved or should anything be done in the interim period to improve the existing inadequacy of medical relief by using the Indigenous System? And if something is to be attempted, what line should it take?

Popular View.—There are many thinking people who consider that while a comprehensive and rational system of public health is being evolved, use should be made of Indigenous Medicine. Indigenous System—good, bad or indifferent as it may be—still caters for the needs of the major portion of the population particularly in rural areas. They, therefore, consider that it cannot be excluded altogether from the field, and urge that it should be used to the best advantage while the process of evolution of a perfect system of rationalisation of medicine is being worked out. During this transition period, they also hope that Indigenous Medicine will overhaul itself and become an integral part of the permanent system evolved.

If the existing state of affairs is considered without prejudice, there would appear to be a good deal of justification in favour of this course. Indigenous Medicine should be given a fair opportunity to overhaul itself, to discard what is useless, and to bring up-to-date, in the light of modern discoveries, what is intrinsically efficient and useful in it. It is also to be remembered that the people who still use Indigenous Medicine do not all belong to the ignorant and the uneducated class. A portion of the high intelligentsia in the country, who can think for themselves, believe in its efficacy, and it is reasonable to suppose that they must be getting some benefit out of it to think in this way. One is, therefore, forced to conclude that Western Medicine has not attempted to understand the Indigenous systems, and has been carried away by the inherent prejudices of the foreigners who have hitherto controlled the destinies of medical relief in this country. But while one can understand the European medical practitioner not understanding the value of Indigenous Medicine, it is not possible to endorse the views of the Indian practitioners of standing, when they assert that no notice should be taken of it, as it is archaic and obsolete, and therefore more or less useless. This attitude shows a lack of appreciation of the fundamentals and practice of their own system, and makes it essential to reorient their ideas with regard to the extension of medical relief.

Synthesis of Modern and Indigenous Medicine

I have always held that some of the distinctions drawn between the various systems of medicine practised in this country and which have given rise to the prejudices in the minds of the advocates of one system against even the good points of another, are unreasonable and unscientific. The universal and cosmopolitan nature of medicine does, of course, vary according to environment, and with the advance of knowledge necessary adjustments have to be made. But the only solution for rationalisation of medicine is the evolution of a country-wide extension of a system, which can be regarded in the words of the Bhore Committee, "neither as Eastern nor

Western but is a corpus of scientific knowledge and practice belonging to the whole world to which every country has made its contribution."

Regarding this question I feel that a thorough-going synthesis may, at present result in the almost complete submergence of the indigenous into the Western system. For, the Western system is based on the surer foundations of biological and physical sciences, and has all the recent facilities for diagnosis, cure and prevention at its command. Moreover, any real synthesis will take many years to work out.

The Indigenous system, on the other hand, is cheap and suits the pockets of the poor, and being widespread, serves a very large number. Under modern democratic conditions the State too can not be indifferent to what is popular with its people. Such a cheap and popular system can not be ignored and we must consider whether the building up of efficient health services in the country can not be extended and accelerated through its addition to the State-sponsored Western system.

Western medicine, which at present dominates the country and is the system recognized by the State, should discard its narrow outlook of contempt for anything which is not its own. The Indigenous medicine, on the other hand, should discard its inherent prejudices and bring itself up-to-date by incorporating from other systems all that is of value. The practitioners of indigenous medicine should understand that in these days no claims of esoteric knowledge can be entertained, nor origin, antiquity and fancied utility urged as justifications.

Is a Synthesis Possible?—In connection with the rationalisation of medical practice in India two important questions suggest themselves. Firstly, can the practice of medicine be so regulated by the exponents of modern and of the indigenous systems that the fullest possible use is made of the facilities available for diagnosis, treatment and prevention of disease? I have already alluded to this. The second question is, can a synthesis of indigenous and modern systems of medicine be attempted so as to promote the utilisation of the knowledge from all available sources for the interpretation of health and disease and for diagnostic, curative and preventive purposes?

A Partial Synthesis.—I believe that both extension and acceleration are possible through what may be called a partial synthesis of the two systems, in the elementary stages of our teaching. The present course of study in the indigenous medicine should be suitably curtailed on one side and enlarged on the other. On the side of curtailment, I suggest that the teaching of subjects like Anatomy, Physiology and Pathology should be reduced to some extent. Their inclusion, on the present scale, in the curriculum of the Indigenous medicine leads to considerable confusion in the minds of the students. In passing, it may be mentioned that this reduction in studies will go parallel to the reduction in the studies of students of Western medicine, as proposed by the Bhore Committee. On the side of enlargement, I suggest that in addition to the basic principle of Ayurveda and Unani the students should be taught the basic principles of Western medicine. They should also be given training in preventive health measures.

The net effect of this suggestion will be twofold. It will shorten considerably the period of study and thus lead to the training of a much larger number of qualified practitioners. And, secondly while giving the students a sufficient background of scientific knowledge with regard to the diagnosis, treatment and prevention of disease, it, at the same time will make them conscious of their own limitations, and of the necessity to appeal to higher practice in difficult cases. There are about a hundred thousand practitioners of indigenous medicine in India, many of whom could be quickly fitted for this purpose after suitable training.

Those who are likely to object to this curtailment and partial synthesis, should bear in mind that nearly 80 per cent of ailments are of a minor nature and can be dealt with by simple medical and surgical measures and require no advanced knowledge of the theory of diagnosis and treatment. Moreover, the suggested training will enable the practitioner, to become an integral part of the health services, and thus the administrative difficulties now being experienced in some provinces through a dual system of medical relief will be avoided.

The services of such practitioners will be of particular value in the rural areas, which are now almost beyond the reach of modern medicine. Rural medical relief will be considerably facilitated if some further steps are taken to standardise medical practice by prescribing uniform scales of drugs and medical appliances for institutions, their production in bulk and distribution under the auspices of the State. If all practitioners are properly registered and practice by non-registered practitioners prohibited, a reasonable standard of competence could be secured by prescribing and enforcing the necessary rules regarding an expeditious system of training and examination in respect of their qualifying diplomas.

Research in Indigenous Medicine

Importance of Research.—Nothing can remain static in this dynamic universe, and the ever-changing world needs every-changing methods to deal with its ever-changing problems. Indigenous medi-

cine can be no exception to this rule. While this partial and workable synthesis is taken in hand, I would earnestly suggest that careful research be made by the exponents of the indigenous medicine so as to link their system with the modern medicine. There is nothing derogatory in this. But the work can only be taken up by the learned *Vaids* and *Hakims* and is bound to take time ; and yet, if this is not done their systems are bound to become entirely obsolete. The process of rationalization of their materia medica should be comparatively easy, and has already been taken up by a number of workers outside these systems

A reference has, however, to be made here to the unreasonable attitude adopted by some of the indigenous practitioners towards the workers outside their own fold. They consider that investigation of their drugs by methods of chemical analysis and biological testing developed by science, serves little purpose. It is opined that there is something mysterious in the action of "whole drugs" which cannot be investigated or elucidated by such tests. It is possible that there may be some such factors. The discovery of antibiotics and hormones in plants to which no importance was previously attached may lend support to these views. But these should be explained and the mystery cleared by efforts of the exponents in the light of present knowledge. If they do this, a complete synthesis will not be a remote possibility If they fail, the world outside cannot be blamed if it refuses to believe their theories. The present day world cannot accept any fantastic views whatever be their origin and however strong their following. The result will be their complete extinction in the course of time.

The outside workers should not be depressed by the hostile attitude and should go ahead. Every little contribution adds to our knowledge and may help materially towards the alleviation of human suffering

I now give some concrete suggestions for Research in Drugs, in Indigenous Materia Medica, for Drug Standardisation, Manufacture and Control which are essential for rationalisation.

. Drugs and Medical Requisites

Central Institute for Drug Research.—My first suggestion is that a Central Institute for Drug Research should be established at the earliest possible opportunity. The lines on which the Institute should work have already been endorsed by the Council of Scientific and Industrial Research. The Institute will ensure the fullest collaboration between all the allied sciences concerned in drug research, between the scientists themselves, and between them and the industry. By rationalising the Materia Medica, the Institute will help considerably the rationalisation and extension of Medical Relief all over the country and particularly in the rural areas

It is worth recording that the beginnings of this work were laid down by me more than a quarter of a century back at the School of Tropical Medicine, Calcutta. As a result of the activities at that School, botanical identification, chemical analysis, pharmacological studies and clinical trials of a large number of commonly used drugs have been completed Rational explanation with regard to the efficacy of some of these drugs has thus been forthcoming, and a number of these drugs are now largely used by medical practitioners in the country. But only the fringe of this vast subject has yet been touched. It would be for the proposed Institute to take up this work on an extensive scale in all its details.

All sections of the Institute should be liberally staffed and generously equipped. It should perform the dual function of investigating the indigenous materia medica on scientific lines so that it can be brought into more extensive use, and of synthesizing and evaluating with special reference to the requirements of this country, the new remedies which are being daily introduced by scientific organizations and firms of repute. In so far as these remedies are essential for the welfare of the people, economic commercial processes for their manufacture should be worked out immediately. Had such an institute been established after World War I, the acute shortage of drugs which was experienced during the World War II would not have occurred. The country would have been self-supporting with regard to medicinal agents of every description. Further the price of drugs would have been brought down to the economic level of the people. Such a scheme does not preclude the existence of individual foci of research in universities and other research organisation ; on the other hand these should be encouraged more than ever This Institute should also be independent of the work envisaged in the Drug Control Laboratory, and in the Divisions of Biochemistry and Biological Evaluation of the National Chemical Laboratory.

The Central Institute should have a fully equipped special section in which the exponents of the indigenous medicine can work in their own way, rationalise their materia medica and demonstrate its efficacy to the world.

The reason why a Central Institute has not been brought into existence is that the vested foreign interests wanted this country to remain the largest dumping market in the world of all kinds of drugs, good or bad.

Panel on Drugs and Fine Chemicals.—The Bhore Committee, to which I have already referred, gave

...ious consideration to requirements of the country as regards essential drugs and other medical requisites. They considered that for the better medical relief organisation of the country, the therapeutic substances and medical appliances came second in importance only to the adequate number of personnel needed by the country and they stressed the extreme importance of making the country self-supporting as regards drugs and medical requisites of every description. They pointedly drew attention to the disruption of the medical relief organisation of the country brought about by the shortage of drugs and medical appliances caused by the War. They strongly felt that India must never suffer that fate again. They brushed aside the usual arguments advanced against the manufacture of drugs and medical appliances in the country, such as that the cost of production in the country would be greater or that the raw materials for the manufacture of drugs were not available in the country or that certain drugs and appliances were of such a highly specialised character that they would take long to produce in India and then the difficulty of patents. They considered these arguments and came to the conclusion that these objections made it all the more important to plan on a wider basis. India has enough talent and more than enough, and if it is properly exploited, it could match production anywhere. They definitely stated that the lack of raw materials for making synthetic drugs in India was an additional reason why in addition to the drugs the raw materials should also be produced in the country and they saw no difficulty in such a manufacture being made a success. However, they recommended that an *ad hoc* committee should be appointed by the Government of India to go into the question.

Such a Committee was instituted by the Planning and Development Department of the Government of India in 1945 under my chairmanship. On this Panel for Fine Chemicals, Drugs and Pharmaceuticals, were represented the leading scientists and the representatives of the important drug manufacturers in the country, and the services of an eminent consulting chemical engineer from the U. S. A. were made available in an advisory capacity. This committee thoroughly went into the question and produced a valuable Report in 1946. I particularly want to draw your attention to some of the salient recommendations made by the Panel. The country must produce all essential drugs and make them available for use of the masses at economic prices. It was specifically recommended that the manufacture of two types of drugs should be undertaken immediately, namely (1) those which are essential for guarding the health of the public and warding off infectious diseases and (2) those for which India already has or can easily develop raw material in abundance. Under the first category come sulpha drugs, antimalarials, antibiotics like Penicillin, Streptomycin, etc. The arsenicals and D.D.T. can also be included in this list. The Panel recommended that the manufacture of these drugs should be taken up immediately and recommended that Government should take up the initiative and put up the first plants which should serve as models. I wish to draw special attention to this recommendation, and its full significance will be understood when you realise that the representatives of commercial firms, who were present, fully endorsed the view that the first plants should be put up by Government. These would serve as models for the industry and provide a training ground for personnel. Further, these drugs are needed by the poorest of the poor and they must be made available to the health authorities at the lowest possible cost.

In the second group come drugs of vegetable origin. The production of the drugs from vegetable sources, such as quinine, emetine, morphine, caffeine, ephedrine, santonin, essential oils, etc., should be developed to the fullest possible extent, both for the needs of the country and also for export. These drugs are literally to be treated as the wealth of the country and should be exported to good purpose.

Deputation to England and the U. S. A.—In consonance with the recommendation of this Panel, the Government of India deputed two distinguished scientists from the Haffkine Institute to go to England and America to explore the possibility of the manufacture of antibiotics, sulpha and antimalarial drugs. They returned to India by the end of November last year and submitted their Report to the Government of India, Department of Industries and Supplies. I have seen this Report and can say without hesitation that the Report is of great national importance for more reasons than one. In the first place, it gives complete data which are necessary for undertaking the manufacture of drugs and these data show clearly that all these drugs can be made much cheaper in India, at about 1/5th the cost, than they can be imported from abroad, and when the question of the treatment of millions of the poorest of the poor is involved, this is a matter of very important consideration. But the making of these drugs is not to be recommended solely on the grounds of saving money.

A Valuable Training Centre.—The making of drugs in the country in a State Institute would mean greatly increased production. If the drugs are manufactured in the country, we would have an excellent training centre, such as we do not possess at present. The Government of India is incurring a heavy expenditure for sanding men abroad for training. It should be realised that no country abroad gives training in industrial production readily. Dr. B. C. Roy recently stated that though he could get promises of

great deal of facilities for academic training of our men, he was not so successful as regards industrial training in manufacturing concerns Here lies the importance of the scheme We have workers who have gained the experience of production and have the necessary ability and are actually producing these drugs in a semi-commercial scale in laboratories like the Haffkine Institute. We should now put up a large plant under public auspices, which will provide those facilities for training which the country has so far lacked and without which the country will get nowhere This will provide a first-class modern chemical plant and research laboratory for training for drugs and fine chemical manufacture. If such a scheme materialises, I feel confident that within a few years, we would train hundreds of new chemists and within a reasonable period, say 10-15 years, the country would become fully self-sufficient and would not have to depend on foreign import.

Vegetable Wealth of the Country. The question of the manufacture of the second type of drugs I have mentioned above is equally important Here we have literally ready made wealth in our hands and in these days of lack of dollar credits, we can use this great wealth of the country to very good purpose for foreign markets. A start has already been made in this direction, only now the Government must take a hand and put the production on a proper basis.

I would, therefore, urge the Government of India to immediately consider these propositions and take steps to implement them. I have said before that even the Panel on which representatives of commercial firms were represented, had no hesitation in saying that the first plants for the manufacture of synthetic drugs like sulpha drugs and antibiotics must be put up by the State and now that we have the necessary knowledge and trained personnel, there is no reason why the interests of the country be damaged by delaying the implementation of the proposed scheme which is essential for the rationalisation of medicine.

Research in Indigenous Materia Medica

This work must be carried out in a systematic manner under the following sections: –

Identification of Plants.—The materia medica of indigenous medicine consists predominantly of substances derived from the vegetable kingdom and practically all the plants used, grow in India. In the investigation of these plants the greatest difficulty I encountered in the beginning was that many plants mentioned in the literature baffled and defied recognition and identification. The descriptions in the old texts were in such vague and general terms that it was often impossible to be certain whether the specimens obtained were of the drug described. The identification of drugs is naturally not possible until prominent characteristics of each plant are established But the verbal descriptions, as given in the old literature, could not enable the botanist to identify plants and parts of plants which even in themselves do not invariably present the same characteristics and even the learned exponents of indigenous medicine cannot, with certainty, indicate which is the authentic specimen mentioned in the old texts. As a result considerable confusion has arisen in the literature of indigenous medicine. Again, many drugs are frequently sold under different names, and entirely different drugs often under the same name. Very careful and detailed enquiries had, therefore, to be made before a plant could be taken up for investigation. In the work of identification help was at first obtained from the works of Western writers of the 19th century such as Jones, Ainslie, Roxburgh, Wallich, Dymock, Watt, and others, who had carried out laborious studies to classify these plants. This also did not solve all the practical difficulties that arose.

Bureau of Plant Industry. The great handicap was that there has not been in this country a proper organisation corresponding to the Bureaus of Plant Industry in advanced countries which collect and keep the information concerning plants up-to-date and encourage investigation and research. The Botanical Survey of India (Economic Products Section) and Forest Research Institute (Minor Products Section do some scattered work in this connection but the whole work must be unified and concentrated so that full collaboration with allied organisations can be established

For collecting and supplying all information regarding plants, a Bureau of Plant Industry on the lines of that existing in the United States of America and in the U. S. S. R. should be established under the Ministry of Agriculture. The Bureau in America can serve as a model. It carries on its activities under the Department of Agriculture in collaboration with agencies such as Bureau of Entomology and Plant Quarantine, Federal Crop Insurance Corporation, Federal Surplus Commodities Corporation Forest Services, Office of Foreign Agricultural Relations, Agricultural Marketing Service, Food and Drug Administration, etc. Any organisation planning to stimulate the cultivation and development of medicinal plants in this country must collaborate with scientific workers in allied branches for the solution of inter-related problems. The functions which such a Bureau could usefully perform, are multifarious and should be worked out according to the requirements of the country. For example, it could collect

and maintain up-to-date information with regard to all plants of economic importance by carrying out surveys and collecting statistical data regarding their export and import. It could have information with regard to new species which can be successfully introduced and commercially developed and about markets in India and abroad. It should have knowledge regarding the quality and quantity of drugs growing in a state of nature and which are and can be successfully cultivated. Substitutes of pharmacopœial drugs which might serve the same therapeutic purposes could be investigated under this auspices and brought into use. The Indian drug trade has seriously suffered because the quality of drugs has not been maintained and adulteration has been rife. The Bureau could exercise quality control and regulate drug trade by establishing drug emporia which could act as a central clearing houses for authentic drugs. It should establish herbaria for the various types of economic plants. Detailed surveys of grass lands and other localities would be the function of this Bureau so that measures for protecting live-stock against the menace of poisoning could be adopted.

Foreign Agricultural Relations. The Sections on Foreign Agricultural Relations should be an important part of this Bureau if a separate Bureau for this purpose is not established. This will help "in addition to other activities, medicinal plant culture by publishing statistical information showing the principal market outlets for such botanicals nearest to their point of production and by establishing liaison with countries through diplomatic and other channels, for procurement of seeds and other agricultural information necessary for the acclimatization of a new crop of economic and industrial significance".

Herbarium of Medicinal Plants.—The section of Bureau of Plant Industry should have along with it a special section of Herbaria of Medicinal and Economic Plants. Herbaria are urgently needed for food and fodder plants, grasses and for plant poisonous to men and animals, edible and poisonous fungi, algae, mosses, etc. Knowledge regarding these plants is lacking at present.

There is, no doubt, a large herbarium in the Botanical Gardens at Sibpur, Calcutta, but the specimens are so mixed up that to look up for a specimen is like hunting for a needle in a haystock. In order, therefore, to facilitate the work on indigenous drugs some years back, I decided to build up a reference herbarium containing authenticated specimens of all medicinal plants growing in the country. The collection of such a herbarium was slow at first, but was speeded up when grants for the purpose were sanctioned by the Indian Research Fund Association and the Imperial Council of Agricultural Research. A well-equipped botanical unit was established for making collections of plants from all parts of India and for their proper preservation and identification. By extensive investigations and collections in the field and by laborious studies in all the existing local herbaria in different parts of the country, about 10,000 specimens of nearly two thousand of the common species of medicinal plants were collected. Several sheets of each species were prepared, and to ensure perpetuity and enhance and extend their utility to scientific workers, three more or less, complete sets of specimens were housed at the Forest Research Institute, Dehra Dun, the School of Tropical Medicine, Calcutta, and at the Drug Research Laboratory in Kashmir State. A few hundreds of the uncommon species have still to be collected and this is being gradually done; this work could be expeditiously done by the Bureau of Plant Industry. This Herbarium is already becoming known and is being used by scientific workers.

Survey of Medicinal and Poisonous Plants.—Side by side with the survey of the distribution of medicinal plants, there should be a section on Survey of Poisonous Plants and Food and Fodder Plants. A preliminary survey was made by me, years back. The exact habitats of plants growing in a state of nature or otherwise were verified during extensive tours and a lot of existing confusion was cleared up. Many of the medicinal plants are poisonous to man and animals, and in the course of the survey, notice was taken of those which have toxic properties but are not used in medicine. It was very soon realised that while much work had been done on this group in Europe, America, South Africa and other countries, no systematic work had so far been attempted in India.

But much remains to be done. The distribution of many plants as described in the literature of indigenous medicine in the latter half of the 19th century is often vague and inaccuracies which have crept in have passed from one book to another. Again plants may change their habitats and exotics may come in. Such a survey is, therefore, important not only from the point of view of distribution of medicinal plants but in other respects also.

Further, for the extension of medical relief on rational lines it is not only necessary to make a scientific study of these plants but to cultivate them for therapeutic use if need be. The only way in which it is possible to determine the areas of optimum production, with any degree of accuracy, is first to find out whether a particular plant grows well and in abundance or is scarce in any particular area. These studies alone can provide the basic information regarding the suitability of localities for the cultivation of different plants. The gradual development of such work has led to the cultivation of a number

of plants of great utility with as good active principle-contents, as are found anywhere else.

The medical and toxicological aspects of the Cryptogamic flora of India constitute an almost unexplored field. We have very little information about the deleterious effects produced by Indian algae Many of the fungi such as rusts, smuts, etc., attack food and fodder, while poisonous mushrooms grow in many parts. Many more poisonous species exist than have been studied, and about these also little or no information is available. The same applies to liverworts and mosses of India.

Poisonous Plants and Insecticides.—So far as the Phanerogams (flowering plants) are concerned, two main groups exist: (*a*) the group of plants poisonous to man and livestock. This is a large one, and while considerable information is available about plants poisonous to man, knowledge regarding poisoning of the livestock is meagre. India possesses roughly a third of the bovine population of the world and the question of its fodder supply is of utmost importance. Even in countries like America, where much is known about these plants, the figures of losses suffered through poisoning are high. Similar figures of losses are not available in India, but they are sure to be very high. Unless detailed information about these plants is available, preventive measure cannot be adopted. Grasses form an important part of the food of animals and some of these develop dangerously large quantities of hydrocyanic acid, flourides, etc., under certain climatic and soil conditions, especially in time of drought when plants have become wilted and stunted.

(*b*) The group of plants poisonous to insects and fish is also important in the economy of the nation. Insects do incalculable harm and are responsible for a considerable loss of life and destruction of property. On a moderate computation the annual loss caused to India through insect pests has been put at 2,000 millions of rupees and over a million and a half in human lives. An effective control of these enemies of social and economic progress will reduce this enormous loss and will facilitate national development. One means of fighting them is by insecticides which could be supplied by this group of plants. In spite of the development of cheap, synthetic and potent insecticides, such as D. D. T., vegetable insecticides still hold a prominent place, as they are less deleterious to warm blooded animals and plant life and possess immediate knock-out effects.

Cultivation of Medicinal Plants.—The acute shortage of drugs during the World War II drew attention to this important subject and a good deal of interest is now being taken to give it a practical shape. Most of the drugs required for therapeutic purposes are grown in this country. Those which do not grow can be grown in selected places. Among the exotics of great practical utility which have been successfully cultivated may be mentioned cinchona, ipecacuanha, digitalis, pyrethrum and others. It should be realised, however, that this is no novice's work but needs specialised knowledge and guidance of a scientific organisation. The soil, the season of planting, the gathering time, hybridisation, plant diseases, etc., are some of the important factors which call for expert attention in connection with the active principle of plants. The collaborative efforts of plant culturists, pharmacognosists, pharmacists, pharmacologists, entomologists and chemists, are essential and these could be made available only by such organisations as the Central Institute for Drug Research, Bureau of Plant Industry, Foreign Agricultural Relations Bureau, etc.

Drug Standardisation and Drug Control

Rationalisation of medicine is not possible till the drugs in use are standardised and controlled. This applies with equal force to the drugs used in Indigenous medicine.

Adulteration.—It has been shown that a large number of drugs and pharmaceutical preparations marketed in this country, vary a good deal in regard to the potency claimed for them. While a certain amount of deterioration in active principles takes place through climatic factors and effects of storage, it has also to be admitted that often open and wilful adulteration of many remedies is being practised. To rectify this state of affairs, the Government of India appointed the Drugs Enquiry Committee of 1930-31 under my direction. Investigation on an extensive scale showed that the position was even worse than had been believed. The Committee submitted its report early in 1931 but unfortunately legislation could not be enacted till 1940, and owing to the exigencies of War, it was not possible to establish the machinery for implementing it till April last year (1947). This legislation, while it is far from perfect, should help materially towards stabilizing the quality of drugs in this country.

The Committee unfortunately could not suggest any action with regard to the drugs used extensively in the indigenous medicine, although there was abundant evidence that these were extensively adulterated and were often of inferior quality. The main reason was that the active principles of many of the drugs had not been identified and, therefore, no standards could be laid down for their control.

The protagonists of indigenous medicine should realize that unless standards are established for drugs they use, either by their own methods, or by the generally accepted chemical and biological assay, the

cacy of their drugs cannot be guaranteed. Esta-hment of standards for all drugs and their in-sion in the Indian Pharmacopœia of the future is olutely essential before such drugs can play an ctive role in a rational system of treatment.

Indian Pharmacopœia.—A National Pharma-œia is primarily meant to meet the claims and atisfy the needs of a particular group of physicians a particular time. The object of a pharmaco-a is, in the words of founders of the United States armacopoeia, "to select from among substances ch have medicinal power, those the utility of ich is most fully established and best understood, d to form from these, preparations and composi-s in which their powers may be exerted to the atest advantage". The modern pharmacopoeia is ook of standards, its fundamental objects are "to vide standards for drugs and medicines of thera-tic usefulness or pharmaceutic necessity, suffi-ntly used in medical practice ; to lay down tests the identity, quality and purity, to ensure, as as possible, uniformity in physical properties and ive constituents". In other words, usage—onal usage and scientific usage are bases of judge-nt Such criteria are no less applicable to indi-ous medicine as to Western or any other system medicine wherever practised.

The Drugs Enquiry Committee considered the tion of compilation of an Indian Pharmacopœia came to the conclusion that there were cogent ntific reasons in favour of it. The methods of apy vary in different countries. The raw mate-ls from which medicinal preparations are made do possess the same qualities, and may not be avail-so readily in one part of the country as in other. The effect of climatic conditions on the rmaceutical processes has to be studied. Racial ations in dosage also have to be considered. For e reasons the pharmacopœia one country is not ays applicable to another country. It is essential, efore, that each country should evolve a pharma-ia best suited to its own peculiar climatic and al factors. It should include the therapeutically ve substances of known composition, of definite n, of well-established therapeutic use, of known city, and with necessary standards for determin-safe maximum dosages. In the case of the drugs in use, it is essential that requisite standards should be established for strength and purity of the mate-rials which are to be used in treatment.

A Permanent Pharmacopœia Committee.—Such standards are being gradually worked out and have actually been evolved in case of a number of drugs used in the practice of medicine both indigenous and modern. It is gratifying to note that at last the foundation of such an essential work has been laid by the publication of an Indian Pharmacopœial List complied by a Committee appointed by the Central Health Ministry (formerly Health Department) of which I was the chairman. This work should be considerably extended by the proposed Central Institute for Drug Research and other research orga-nisations. A permanent Committee should be set up on the lines of British Pharmacopœia Commission or the organisation in the U. S. A. to build up an Indian Pharmacopœia including all drugs of value in the practice of medicine in this country. This can be accomplished in the very near future if all faci-lities are made available. Such a Pharmacopœia is essential for rationalisation of medicine in this country and will act as a bulwark against the present tendency towards irrational practice.

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SHORT LIFE SKETCHES
OF THE
General President and Sectional Presidents

General President

SIR RAM NATH CHOPRA, the first son of Dewan Raghu Nath Chopra, was born in Gujranwalla, West Punjab in 1883. As a young boy, he was of a timid nature and slightly built, but showed keenness for his school work from the very beginning. After a fairly successful school career, he joined the Punjab University and graduated from there early in 1902. His teachers in the University were so favourably impressed with his sweet disposition and zeal for studies that they advised his father to send him to England for higher studies. During the summer of 1902, Chopra proceeded to England and enrolled himself in Downing College, Cambridge. Here he stayed for six years obtaining his Science Tripos in 1905, L.R.C.P., M.R.C.S. (Eng.) in 1907, and M.B., B.Ch. (Cantab.) in 1908. British medicine and physiology was at the zenith of reputation at this period under such internationally renowned exponents as Barcroft, Langley, Gaskell, Nuttal, Dixon, Horder, Clifford Albutt, Osler, Langdon-Brown, etc., and he had the good fortune of coming under the inspiring influence of some of these teachers. Deciding to take up medical research as his life's career, Chopra enteted the laboratories of Professor Dixon and took up specialized study in that field of advanced physiology which deals with the action of chemical agents on biological tissues (pharmacology). Under the direction of the late Professor Dixon, he prepared a thesis entitled 'Action of drugs on ciliary movement in the respiratory tract', which later won him the degree of Doctor of Medicine in 1912.

Chopra entered the St. Bartholomew's Hospital while still enrolled at Cambridge, and towards the latter part of 1908, competed for the I.M.S. examination standing third in order of merit. As a young I.M.S. officer he saw active service first in East Africa and later in the Afghan War, for nearly 12 years. For a man of Chopra's temperament and keenness for research and academic work, it must have been a great relief when the School of Tropical Medicine was established through the untiring efforts of Sir Leonard Rogers and he was chosen to occupy the chair of pharmacology at this institution in 1921. Here he continued to work for the next 20 years, becoming Director of the Institution in 1934. He retired from the School of Tropical Medicine in 1941 and took up an appointment with the Government of the Kashmir State, first as its Director of Medical Services and later as Director of a Drug Research Laboratory which the State Government established for the first time under his inspiration and guidance. At present, he is still actively engaged in building up a research centre here for work on the botany, chemistry and pharmacology of Indian drugs.

Chopra's contributions to medical science cover a wide range of subjects. The main theme, which seems to have attracted his attention early and to which he returned again and again, was the study of Indian indigenous drugs—their chemical composition, the physiological action of their active principles on living tissues *in vivo* and in *vitro*, and the bio-chemical and bio-physical changes brought about in mammalian organisms on the administration of these active principles. The aim and scope of the work, as he conceived it as early as 1922, was as follows :—

(1) To make India self-supporting by enabling her to utilize the drugs produced in the

country, by manufacturing them in a form suitable for administration.

(2) To discover remedies from the claims of Ayurvedic, Tibbi and other indigenous sources suitable to be employed by the exponents of western medicine.

(3) To discover the means of effecting economy, so that these remedies might fall within the means of the great masses in India whose economic condition is very low.

(4) And eventually, to prepare an Indian Pharmacopoeia.

From scientific and academic viewpoints, the work on indigenous drugs has set up a high standard of medical and chemical research in India and has focussed international attention to it. Its value from the economic viewpoint is no less worthy of note, as it has given a definite fillip to the Indian drug industry. Chopra's book on 'Indigenous Drugs of India' and 'Medicinal and Poisonous Plants of India' (2 volumes) will stand as lasting monuments of his enthusiasm and endeavour in a field which has seldom been trodden by scientific medical workers.

Another side of Chopra's interest in the development of pharmacological work in India manifested itself in a large number of his published papers and in his book on 'Tropical Therapeutics' and 'Anthelmintics'. He was one of those who wanted to bridge the gap between pharmacology, therapeutics, and clinical medicine. Most of his work therefore leaned heavily towards studying problems of 'applied and practical' aspects of clinical medicine and experimental therapeutics. He effectively brought about a liaison between laboratory researches and hospital medicine.

The pioneer work of Chopra in building up Indian pharmacology, and in giving an impetus to medical and scientific research on 'applied' problems of peculiar interest to India, soon marked him out as an outstanding Indian in the field of medical research. Being in an official position of vantage, he could slowly but surely build up a 'School of Pharmacology' by exercising great influence on many pupils at the Calcutta Medical College where he was simultaneously the Professor of Pharmacology for 20 years, as also by supporting junior research workers under him with the help of Government research grants, scholarships, and Fellowships. At the time of his retirement in 1941, he left nearly 25 pupils all over India in various pharmacological chairs and other institutions concerned with drug standardisation work. Chopra is sometimes referred to as the 'Father of Pharmacology' in India, on the analogy of Sir P. C. Ray who is acknowledged on all hands as the 'Father of Modern Indian Chemistry'.

Honours, both in appreciation of his contributions to medical science, and for all his activities in connection with medical and public health organizations and in connection with the initiation and development of the drug control organization in India, came to him from all quarters—from his *alma mater* (Cambridge University), from the University of Calcutta and other scientific bodies in India, Great Britain, Switzerland, Germany, Belgium, North and South America, and from the Government under which he served for a long period. He was Chairman of the Drugs Enquiry Committee of the Government of India in 1930-31, Vice-President of the Royal Asiatic Society and President of the National Institute of Sciences. He has also served as the Chairman of the Indian Pharmacopoeial List Committee, the Advisory Panel on Drugs and Medicines of the Government of India, College of Pharmacy Committee of the Government of Bengal, and as a member of the Bhore Sub-Committee, the Drugs and Pharmaceuticals Committee of the Council of Scientific and Industrial Research and Scientific Committees of the Central Government both in the Medical and other scientific departments. Inspite of his busy life and high official position, Chopra always succeeded in maintaining a simple personality and cool temperament and has thus been able to promote that collaborative effort amongst various groups of scientists which is now considered to be the keynote of success in the field of medical research

B. M.

L. A. RAMDAS

President, Section of Physics

Dr L. A. Ramdas was born on the 3rd June 1900. He is the third son of the late Diwan Bahadur Dr L. K. Ananthakrishna Iyer, the eminent Indian Anthropologist who founded and held charge of the School of Anthropology in the Calcutta University during the years 1920-30 and had taken a leading part in the Indian Science Congress Association from its very beginning.

Dr Ramdas and his three brothers had been brought up under the scholarly atmosphere of his father. He had his schooling at Trichur and Ernakulam in the Cochin State, which was the scene of his father's early labours in the field of Anthropology. Thereafter he took his B.A. degree in Physics from the Presidency College, Madras in 1920. By this time Sir (then Professor) C. V. Raman had already commenced his distinguished career as Palit Professor of Physics at the University of Calcutta and Secretary of the Indian Association for the Cultivation of Science. Like other young aspirants to

distinction in Physics, young Ramdas too proceeded to Calcutta where he came under the inspiring influence of Prof. Raman. After taking the M.A. degree in Physics, he joined Prof. Raman as Palit Research Scholar. The classical researches of Raman and his school on the scattering of light by gases, liquids and solids had already started. Within a

short time Ramdas, working at the 'Association', reported his discovery of the Scattering of Light by Liquid Surfaces, a phenomenon caused by the agitation of these surfaces by molecular bombardment. This discovery was pursued vigorously during the next three years and the results discussed in a series of papers. Ramdas investigated the optical properties of liquid surfaces, mono-molecular films on water and explained the movements of camphor and other substances on a clean surface of water. He submitted his thesis in 1926 and was awarded the Doctorate degree by the Calcutta University early in 1927.

In September 1926 Dr Ramdas joined the Indian Meteorological Service, which has always been a major attraction for physicists in India. After a period of four years, during which he played his part in developing the early stages of aviation-meteorology at Karachi, Dr Ramdas took charge of the new Section of Agricultural Meteorology at Poona in August 1932. This new Section started under the auspices of the Indian Council of Agricultural Research, has now grown, under his able direction, into a permanent and rapidly expanding activity of the India Meteorological Department. The Section is devoted to fundamental research on various aspects of Meteorology and its applications to Agriculture. Dr Ramdas is now designated Director of Agricultural Meteorology. For his pioneer work in Agricultural Meteorology he was awarded the M.B.E. in the King's Birth-day honours list of 1946. Dr Ramdas is a Fellow of the Indian Academy of Sciences, Bangalore, the National Academy of Sciences, Allahabad and the National Institute of Sciences of India. He is also a Fellow of the Royal Meteorological Society, London and a Professional Member of the American Meteorological Society.

Besides his activities in Meteorology, Dr Ramdas has continued, without break, his research work in Physics with the help of a band of voluntary research students at Poona, many of whom have taken their post-graduate degrees from various Indian Universities while working under his guidance.

Dr Ramdas is only 47 years of age.

B. SANJIVA RAO

President, Section of Chemistry

Born on 23rd February, 1896, Dr. B. Sanjiva Rao, had his education at the Central College, Bangalore. After graduating in 1915 he joined the Mysore Government Service as a Demonstrator in Chemistry at the Central College, Bangalore. He

took M.A. degree of the Madras University in 1918 and then proceeded to England for study of Chemical Engineering and Physical Chemistry at the University College, London on the award of the Damodar Das Foreign Scholarship by the Mysore Government. After his return from England in 1926 he was appointed Professor of Inorganic and Physical Chemistry at the Central College to which he became the Principal in 1946. Prof. Rao got the D.Sc. degree of London in 1946 for his investigations on the "Chemical Behaviour of Certain Sulphur Com-

pounds". Prof. Rao joined the Indian Institute of Science, Bangalore in September 1947 as the Nizam Professor of Inorganic and Mineral Chemistry after 22 years' service in the Mysore Government. Dr Rao has specialized in Colloid Chemistry and in the Chemistry of Sulphur Compounds. He has been engaged in investigations on rice since 1931 and was a member of the Indian delegation to the Rice Study Group of the F.A.O. of the United Nations.

K. AHMAD CHOWDHURY

President, Section of Botany

Dr Kafiluddin Ahmad Chowdhury, was born on the 1st February 1902, at Keroa Estate, Raipure, in the district of Noakhali, Bengal. His father, who was the biggest Land Lord in the district, died when young Kafil was only 4 years old. It was his mother who brought him up and gave him proper education. In 1918, he passed the Matriculation examination of the Calcutta University in the 1st Division and joined the Ripon College, Calcutta. In 1922 he passed the

B.A. examination from there and sailed for Europe. In the same year he got himself admitted in the Forestry Department, University of Edinburgh. In 1925 he received B.Sc. in Forestry and stayed on for another year to do some post graduate work. During his stay in United Kingdom he travelled extensively and visited the well known centres of forest botany research there. He had practical training in French forests for about 7 months. He returned to India in 1926 and was appointed Wood Technologist, Forest Research Institute, Dehra Dun, in 1927. In the same year he was sent by the Government of India to U. S. A. and Canada for further studies. He visited all important Laboratories in U. S. A. and Canada, where research on plant anatomy is being done. He returned to India in 1929 and has since been working at Dehra Dun. His researches are on Plant Anatomy, particularly on Wood Anatomy. In recognition of his work on wood anatomy, the University of Edinburgh conferred on him the Degree of Doctor of Science in pure science in 1939. The Government of India also appreciated the value of the work he had done and conferred on him M.B.E. in 1945. Further recognition of his work was made in 1946, when he was elected to be a member of the Council of the International Association of Wood Anatomists. He is the first Indian to receive recognition from this international organization.

A. N. CHATTERJI

President, Section of Anthropology and Archaeology

Born in 1897, Mr Anath Nath Chatterji was educated at St. Xavier's High School and then at the above college. He graduated from the Grant Medical College, Bombay, in 1919. Prof. Chatterji joined the Calcutta University in 1920 as a lecturer in the Anthropology Department and is Honorary

Secretary of the Students' Welfare Committee, Calcutta University since 1922. He is a visiting physician to the Ramrikdas Haralalka Hospitals, Calcutta. Among his publications may be mentioned *'Ho's of Seraikela*—jointly with T. C. Das; *First Studies on the Health and Growth of the Bengalee Students; Bengalee School Boy—his Physical Development.*

BASHIA AHMAD

President, Section of Physiology

After a brilliant career, Dr Bashir Ahmad graduated from the Forman Christian College and the Punjab University, Lahore in 1925, with first class first, and winning several honours and distinctions including a University Scholarship and a gold medal. Afterward he joined University College, London, and obtained Ph.D. in Biochemistry (1931). Later he worked at the John Hopkins University, U S A (1937-38), and at the Biochemical Laboratory of the University of Cambridge, England (1938-39)

Dr Ahmad began career as a lecturer in Chemistry in the Forman Christian College, Lahore and has since held several appointments; Public Health Chemist, Government of Punjab (1928-29); Asst. Professor of Biochemistry and Nutrition, All India Institute of Hygiene and Public Health, Calcutta (1934-40); Professor of Organic Chemistry, Punjab University (1941-44); Assistant Director, National Chemical Laboratory, Council of Scientific and Industrial Research (1945-47) and lately has again returned to the Punjab University as Professor of Organic and Biochemistry and Director of the University Institute of Chemistry.

Dr Ahmad is a member of many scientific societies and organisations both in India and abroad and has taken active part in their development.

Dr Ahmad is the author of more than 100 scientific papers on a wide range of chemical, biochemical and physiological subjects in leading scientific journals; and of numerous brochures on food, nutrition and biochemistry.

N. SEN

President, Section of Engineering and Metallurgy

Nalinbihari Sen, was born on 27th October, 190[illegible] He was educated at Dacca and Calcutta and graduated with First Class Honours in Chemistry. He studied metallurgy at the University of Sheffield and obtained the degree of B.Met with First Class Honours in 1924 and won the Mappin medal and premium and then spent some time carrying out research in metallography under Prof. C. H. Desch, F.R.S., as a George Senior Research Fellow of the Sheffield University

His first industrial experience was obtained at Sheffield steel works but he left that place after a short time and entered the Tata Iron and Steel Co. Ltd. as a metallurgist. He was soon appointed Chief Chemist in charge of the chemical and physical laboratories for the whole Works.

Mr Sen has devoted himself mainly to improvements in the efficiency of the various metallurgical processes and has been mainly responsible for developing modern methods of control in the Works. In 1933 he travelled abroad visiting different government and industrial research laboratories in Germany and England and after his return took a prominent part in the planning and equipment of Tatas Research Laboratories at Jamshedpur where valuable research work is being carried out since their inception immediately before the World War II.

Mr Sen obtained his Degree of Master of Metallurgy and was elected a Fellow of the Institute of Chemistry in 1930. He has been a member of the Council of the Institution of Chemists (India) and was the President of the Bihar Branch for a few years. He has been a member of the British Iron and Steel Institute for some time and was recently elected a Fellow of the Institution of Metallurgists (England).

ZAKIR HUSSAIN

President, Psychology and Educational Science

Dr Zakir Hussain, M.A., Ph.D., India's foremost educational expert to-day, is founder and president of the Jamia Millia, Jamianagar, Delhi, where surrounded by a number of able and distinguished colleagues (many of them with the best foreign education) he is carrying on a series of educational experiments for over 20 years now to remould India's educational system on modern lines with a rational and scientific outlook on the problems of education in India.

Madame Halide Edib, the Turkish feminist leader, devotes an entire chapter to the Jamia Millia and to Dr Zakir Hussain and Prof. Mujeeb, his co-worker, in her famous book *'Inside India'*. A lady visitor to Jamia Millia ten years back, on seeing boys and girls of teen age in class together, asked 'Do you have Co-education here?' The answer given was '*We don't say we have it, it simply exists*'. That answer is typical of the great work they are doing most unassumingly at the Jamia Millia.

This new education movement was started at Aligarh by young nationalist Muslims, led by Dr Zakir Hussain more than 30 years ago under the guidance of Dr M. A. Ansari and Hakim Ajmal Khan. They have all these years held fast to the ideals they gave their allegiance to, determined not to be swayed by any political, communal or economic consideration from the path they had chalked out for themselves at the beginning. Struggling with many adverse circumstances, Dr Zakir Hussain has, at last, been able to uphold the cause he has stood for decades.

Dr Zakir Hussain's ideas and the Jamia Millia's influence are to-day seen imprinted as much on the Wardha Scheme (and Dr Zakir Hussain is the President of the Hindusthani Talimi Sangha) as on the Sargent Plan (and he is one of the most important members of the Central Advisory Board of Education).

Distinguished alike for his presence and character, he commands respect and admiration in educational circles in many parts of the world. Dr Zakir Hussain is a student of the Social Sciences whose mind naturally turned to problems of education because of the close relation between education and society to-day.

S. N. ROY

President, Section of Statistics

Born at Calcutta in 1906, Mr S. N. Roy received his education at the Government High School, Khulna, Presidency College, Calcutta, and the University College of Science and Technology, Calcutta University. He had a uniformly brilliant academic career and obtained the M.Sc. degree in Applied Mathematics in 1930. In 1933 Mr Roy joined the Calcutta University as a research scholar under Prof. N. R. Sen and began his work in Mathematical Physics. In 1935 he joined the Indian Statistical Institute as a research worker and was later appointed a Statistician. Here he took a leading part in research activities of the institute both theoretical and applied. His earlier researches in Statistics were mainly confined to Mathematical theory of Multivariate distributions. He is at present working on the theory of statistical inference. Since 1938, Mr Roy has been serving as a lecturer in the Department of Statistics, Calcutta University, of which he is at present acting as the Head of the Department. He is also the Assistant Director of the Indian Statistical Institute, and an Ordinary Fellow of the National Institute of Sciences of India.

P. K. GHOSH

President, Section of Geology and Geography

Dr P. K Ghosh graduated with Honours in Geology in 1920 and later passed the M.Sc. examination in Geology of the Calcutta University as a student of the Presidency College, Calcutta and was placed in the first class in both the examinations, standing first in order of merit.

Soon after he was awarded the Government of India State Scholarship and he joined the Imperial College of Science and Technology, London where he worked under Prof. Watts on the petrology and structural features of the intrusive granite masses of South-West England. He was admitted to the Ph.D. and D.Sc. degrees of the London University and also obtained the Diploma of the Imperial College.

On his return to India, he joined the Geological Survey of India in 1929 as an Assistant Superintendent, in which capacity he carried out extensive geological survey work in various parts of Rajputana, C. P., and the Eastern States, with special reference to the petrological problems of these areas.

Dr Ghosh has also carried out extensive survey of the mineral springs in India and determined the physical and chemical properties including medicinal properties of the spring waters. In several samples he studied their radio-active properties. His monograph on 'Mineral Springs of India' is a record of monumental work and when published will give the general public of this country a detailed information regarding the properties of these spring waters.

Dr Ghosh is the author of several valuable original papers dealing with mineralogical and petrological properties and his memoir on the Charnockites of Baster State appears to be a valuable contribution in petrology.

Dr Ghosh was elected an Ordinary Fellow of the National Institute of Sciences of India, and the Geological, Mining and Metallurgical Society of India. He is a member of the Mining, Geological and Metallurgical Institute of India, (of which he is a past Secretary and now the Editor of its Transactions), the Royal Asiatic Society of Bengal and the Indian Science Congress Association, to the Geology section of which he has contributed papers from time to time.

Dr Ghosh is now holding the office of the Deputy Directorship of the Geological Survey of India. He served for a period as a Professor of Geology, Presidency College, Calcutta. Dr Ghosh is at present 48 years of age.

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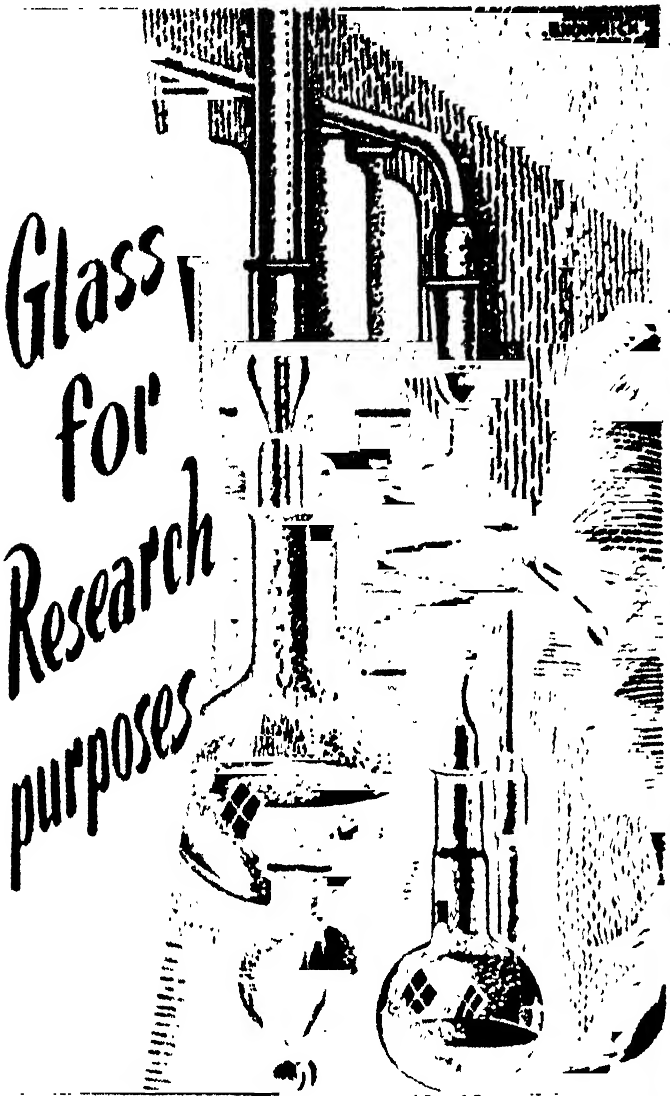

SCIENCE AND CULTURE

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CONTENTS

THE LIGHT OF INDIA

We do express our profound sense of overwhelming grief at the unthinkable and tragic end of the precious life of Mahatma Gandhi, the Soul of India and the Father of our Nation, an apostle of truth, non-violence and love, and the most outstanding man of the present century.

We mourn with the nation the loss of one who was the Light of India, the radiance of which spread and illumined the mind of men all over the globe.

We mourn for him who won for us freedom in his life and tried to wash our sins in his death.

We offer our most reverential homage to his immortal soul.

[Our editorial in memory of the great soul will appear in the next issue]

ScIENCE AND CULTURE

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DEFENCE

DEFENCE against aggression by foreign enemies, and against internal troubles is one of the main functions of the Government of any sovereign country. Now that India has attained this status, it is well to take stock of our present position in this most urgent affair.

It is well to remember that hitherto defence of India was only part of the defence of the farflung British Empire, and with the attainment of independence, India is thrown severely on her own legs. Let us see how far we are able to organize defence under present conditions. What do we require for defence in a modern world? We require army, navy, and air-force. But only experienced generals, trained officers and well-drilled soldiers would not do; we must arm them with weapons and equipments in all the three arms of defence, including not only guns, and rifles, explosives, warships, army telephones, but also since the first World War, tanks and aeroplanes, and as the last war has shown, wireless equipments, radars, and dozens of other items. Have we the means of producing these equipments in our own cuntry, and getting the trained man-power for handling these arms and scientific equipments?

As far as our knowledge of Ordnance Factories in this country goes, India can produce guns up to a certain bore, small arms like rifles, certain amount of explosives but the production figures and expenditure are under veils of secrecy. It is well known and therefore we are betraying no secret when we say that we do not produce a single tank, aeroplane, wireless set, automobile, armoured or civil, and we have no source worth mentioning of petrol without which no modern war is possible, and many of the chemicals essential for explosive have to be got from abroad. Even in peacetime the U. S. A. has put a ban on the export of radars, and on many essential scientific apparatus, and probably the United Kingdom will also follow suit, and probably in case of war even with small powers they can put effective bans on the export of tanks, aeroplanes, petrol and what not?

It is therefore obvious that we are helpless in case of aggression by a major modern power like U. S. A., U. K., or Russia and will continue to be so until our industrial production rises to a capacity commensurate with the size and natural resources of this country. This may take another 25 to 50 years or we may never attain to this stage at all, according to the capacity, will and efficiency of our Government.

But it is well to remember that not only we are incapable of organizing any but moral defence against any great power; in other words, if these powers want to commit aggression we can only protest; but it is not realized that our powers of defence against trouble-shooters within our own country, or in the areas immediately surrounding us, are not very great, on account of

(i) our extremely low industrial capacity, and
(ii) the vacuum created in the defence organizations by the departure of the British.

We have before us some material giving us the organization and activity of Indian Ordnance Factories. They are capable, as mentioned before, only of producing small arms like rifles, and guns up to a certain bore, and some explosives. For heavier arms and newer arms like tanks, aeroplanes, the defence department has made not the slightest attempt within the last 25 years, as they ought to have done, to start any production centre in India, and has not even cared to start any shops or when started, to maintain such shops to the requisite level of efficiency for repair of large quantities of modern war materials, which were stored in India for military purpose

during the war-years. This was, of course, a part of the Imperial Policy.*

But this is only a part of the picture. We have further to remember that under the old imperial policy, the Indian Ordnance Factories were organized in a very peculiar and inefficient way which is being continued. Take for example, the manufacture of guns, howitzers and mortars. The barrels of these weapons are cast in the Ishapore *Metal and Steel Factory*, they are machined and bored in the Cossipore *Gun and Shell Factory* (both in the suburbs of Calcutta), but for being mounted on carriages, they are sent to the Jubbulpore *Gun and Carriage Factory* on a 700-mile railway journey. After being mounted, they are sent to the office of the Superintendent of Proof and Experiment at Balasore, another six hundred miles of railway journey. When they had passed the test, they were distributed in different armouries. The same is the story with respect to the manufacture of shells, bombs and explosives.

All these round-about arrangements would be regarded as extremely costly, and superfluous in any country, but this is not all. There has not been, as far as our information goes, any design and research section for arms anywhere in India. Drawings of arms to be manufactured used to be supplied from England, and production used to be carried on here, under the supervision of British managers and superintendents, who had served as foremen or mechanics in the British arms factories, by bodies of Indian foremen, mechanics and other skilled labour. There was a complete dichotomy between the brain and the hand, in conformity to the practices of caste-ridden India, which the British Imperialists have learnt to use to their own advantage.

There is further a complete hush-hush over military expenditure. We do not know if any of the Ministers of the present Indian Government including the Defence Minister and his Indian staff has cared to know about the total budget of these armament factories, and their annual production. Our information is that in spite of huge expenditure, production has gone down dangerously low. Systematic investigation is necessary to find out not only these figures, but also to find out the percentage of rejections which we are informed is too high in spite of the fact that during the war, very up-to-date and modern machinery have been installed in all the factories.

We would be failing in our duty if we did not point out that the armaments production factories have been the training grounds for a large number of Indian foremen, mechanics, and other skilled hands and thus we have a reserve of trained labour which, under competent management, can be serviceable not only for manufacture of war materials but for much useful peacetime industries. But the top men are mostly British, and there is not, according to our knowledge and information, much difference in mental calibre and necessary accomplishments between these men, and their subordinate Indian foremen, for except for the Inspectorate Branch, the British Government did not care to send their top men in production factories to this country, as the object was to evolve designs in the U. K., and keep them there. In other words, the production factories are working according to the rule of thumb, but guidance being now unavailable from Britain, the factories are without brain-centres which should be created immediately. Further, the large number of dismissals of temporary hands have created a very bad psychology amongst the Indian employees which ought to be removed by skilful handling.

These are some of the points which occur to us, but others would be found if systematic enquiry be made by a competent committee which we think should be immediately appointed. We suggest the following terms of reference for the Committee.

1. To place Indian Nationals in all positions of trust and responsibility in all the production factories, testing and proof inspectorates.

At present, all responsible heads of armament factories happen to be non-Indian Nationals. For obvious reasons, they should not be continued in these positions. If they are found possessed of proper qualifications, they can be reappointed only as experts, under Indian heads.

2. To reclassify and recoordinate all production factories in accordance with the changed political conditions.

3. To advise on the starting of new production factories for manufacture of planes, tanks, large calibre guns, and other weapons and scientific equipments, at present not manufactured in India.

* As examples, we may add that nobody appears to know the whereabouts of the large number of Radar sets which were operated at various centres in India. In course of my travels, I have come across scores of British scientific men who have worked with radar sets near Calcutta, Poona, Bombay and other places and I have tried to trace them in the different disposals godowns. I traced a number of radar sets, but the reader will be shocked to hear that the main receiving unit was in one place, the power unit was in a second place, and the prime movers have been sold *en masse* to big Indian merchants where they are either rusting in godowns or being auctioned to retail dealers. Some of my younger colleagues found that parts of Sperry Gyroscope were lying in scrapheaps, and were being bought by *Kabaries* and ultimately converted to brass *lotas*. Such waste of precious scientific material is criminal folly, particularly when these apparatus could be utilized for peace time research, as is being done in England and U. S. A., and would have been invaluable even for military purpose, even in case of minor wars. I am making these statements with a full sense of responsibility and I am prepared to prove them if the Government appoints an enquiry committee not consisting of officials implicated in this mismanagement. As I have mentioned before, the export of Radar has been prohibited by law from U. S. A., and probably U. K. will also shortly follow.—*M. N. S.*

4. To recommend measures for reorganization of the factories on the basis of modern methods of industrial efficiency.

5. To set up a brains-centre for the armament factories in the form of research and development sections, and to recommend measures for bringing into existence new scientific establishments under this section for development of new arms like radar, rocket projectiles, atomic weapons, etc.

6. To recommend new training centres for the training of personnel, and for operational research.

7. To consider the starting of factories for the manufacture of synthetic petrol, other essential metals, chemicals and alloys without which it is not possible to carry on a modern war.

The National Government has been in the midst of endless troubles since it took office, but in spite of all these difficulties, it has wonderful achievements to its credit wherever the master mind has been applied to problems. For example, look at the liquidation of small Indian States, relics of a feudal age, happening before our very eyes. This would never have happened, if British rule continued or a lesser mind than those of Pandit Nehru and Sardar Patel were at work on these problems. We are afraid that the master minds of the present government had not yet time to apply themselves to the defence problems. But it is as urgent, nay the most urgent of all problems, and it is time that steps were taken to mobilize Indian intellects for the solution of these problems, as the pioneers of the French Revolution did with splendid results in 1793, or the Bolshevik leaders did in 1918, in the midst of civil war and foreign aggression.

It is not our intention to create a state of alarm by the publication of this timely article, and therefore some points in favour of the Indian Union may be noted. All the armament factories and inspectorates are fortunately in the Indian Union, and none of the countries about us have any factories worth mentioning. But this initial advantage should not lull us to a sense of complacency, for when trouble-shooters are conscious of our strength, that alone will be a deterrent against the occurrence of any unpleasant incidence.

THE ECONOMIC POSITION OF A RURAL COMMUNITY IN WESTERN BENGAL

R. B. LAL and K. K. MATHEN,

ALL-INDIA INSTITUTE OF HYGIENE & PUBLIC HEALTH, CALCUTTA

THE present communication is the second article in a series on the Health Problems in a Rural Community in Western Bengal. In the previous communication[1] a passing reference was made to the possible influence of the growth of population on the standard of living. It was observed that the net reproduction rate being only 1·13, the population was growing at a moderate rate. However, in view of the high density (1900 per sq. mile) already attained, even a small increase could not be ignored unless means of subsistence improved correspondingly. Attention was also drawn to the physical strain to which the male population was subjected, due, amongst other things, to the high rate of sickness from which they suffered and to the social customs whereby the female population made little or no contribution to the family income. It was suggested that the working capacity of the population, and probably their mental and physical efficiency, could be considerably enhanced if the amount of sickness could be reduced or recovery expedited. It is however, a vicious circle because in a community where a large mass of people live under conditions of considerable economic stress, their health and general well-being are perhaps more intimately dependent upon their economic position than in communities where the minimum physiological needs are generally satisfied. Indeed, suggestive evidence of the association of sickness with consumption expenditure, more particularly in respect of chronic sickness, was brought out in the General Health Survey[2,3]. Indifferent health, however, was negatively associated with consumption expenditure which would probably imply insensitiveness to minor disorders on the part of the poor. Thus population growth, health, and standard of living constitute three sides of a triangle which merit a more detailed investigation. This, however does not mean that other aspects of community life do not come in for important consideration. When these aspects are also included in the study, as they undoubtedly should be, we would be dealing with a multiangular figure instead of a triangular. Nevertheless the emphasis on their interdependence would remain unaltered.

Before entering into this discussion it would be helpful to obtain a clearer view of each factor separately. The population problem has already been dealt with and a detailed consideration of the health and sickness is contained in the Survey Report. In this communication we propose to present further discussion of the standard of living and of the economic habits of the community.

Standard of living, according to the *Encyclopaedia Britannica,* bears two distinct meanings.[4] In its strictly technical connotation it describes the scale of living which an average individual of the group will strive to maintain and which he will not jeopardize by marrying and undertaking the responsibility of supporting a family. Thus it would denote the scale of living below which no individual will exist in the community except when reduced to poverty by a sudden and unexpected misfortune. Used in this sense, standard of living is a dynamic factor in determining the density of population, the labour supply, the rate of wages and the possibility of future improvement of economic conditions.

In its popular usage the term means a description of the way people actually live in a given time and place. It is a matter of common knowledge that marriage, domesticity and procreation are universally practised traditionally by, if not religiously enjoined on, the great mass of Indian people and the question of maintenance of a particular scale of living hardly enters into discussion at the time of marriage, except in the case of a few enlightened, educated and westernized men. It may, therefore, be said, that for most people in this country, the question of the standard of living in the technical sense does not arise. As regards the popular meaning attached to this term, we may perhaps approach the question of the economic situation of a community in a number of ways, in order to form a composite picture describing the standard of living.

In a discussion like this, the family appropriately forms the unit. As has been explained in a previous communication[7] a simple way to describe the economic conditions of a community is to give a distribution of the families according to the "index of prosperity", a term devised to include two factors *viz.*, the level of consumption expenditure *per capita* and the degree of stability as determined by the proportionate credit or debit balance against income. It must be mentioned, in this connection, that 'prosperity index' is only of local interest in as much as the division of the families in three classes has been effected by taking equalized groups of upper, middle and lower classes according to the level of consumption expenditure. Each of these classes has been further divided into five sub-groups according to the degree of stability. Thus the class which comprises the upper one-third of the families according to con[illegible] sumption expenditure has been divided into five sub[illegible] groups numbered 1 to 5 in descending order [illegible] stability. Similarly the middle-slass families [illegible] divided into sub-groups numbered 6 to 10 and [illegible] lower-class families into sub-groups numbered 11 [illegible] 15. The index of prosperity is the number borne [illegible] each of these sub-groups. The present study rel[illegible] to a random sub-sample of 514 rural families.

The mean annual *per capita* expenditure w[illegible] Rs. 165±56 and the limiting values which divided the families of moderate means from the higher and the lower groups were Rs 180 and Rs. 135 respectiv[illegible] ly. 36 per cent of families lived from hand to mouth and 40 per cent were unable to balance their budg[illegible] and half of these incurred a deficit of 15 per cent [illegible] more. The instability was equally shared by th[illegible] three economic groups. Remembering that the ind[illegible] number of wholesale prices prevailing at the tim[illegible] averaged 239·8 and ranged from 236·3 to 241·2, [illegible] is evident that the average spending capacity w[illegible] very low and even at that level the position w[illegible] precarious in most cases and the distribution [illegible] wealth was uneven.

In order to gain a more realistic idea of th[illegible] standard of living, using the term in the popula[illegible] sense, it is necessary to discuss the various items [illegible] the consumption expenditure. Table I sets out t[illegible] percentages of average expenditure for each ite[illegible] separately, on the consumption expenditure exclud[illegible] ing debt discharge and on total expenditure whic[illegible] includes debt discharge and expenditure on produ[illegible] tion.

TABLE I

DISTRIBUTION OF THE AVERAGE ANNUAL EXPENDITURE *per capita* ON VARIOUS ITEMS

Items of Expenditure	Actual (in rupees)	Percentage on consumption expenditure.	Percenta[illegible] on tot[illegible] expendi[illegible]
Food	147·8	86·9	72·6
Fuel & light ...	3·9	2·3	1·9
House rent or tax ...	0·4	0·2	0·2
Clothing, bedding and footwear	11·2	6·6	5·5
Toilet	0·4	0·2	0·2
Furniture	0·3	0·2	0·2
Education	1·0	0·6	0·5
Medical advice and medicines	2·5	1·5	[illegible]
Travelling	1·2	0·7	[illegible]
Ceremonies	0·7	0·4	[illegible]
Miscellaneous ..	0·6	0·4	[illegible]
Production	31·5	—	[illegible]
Debt discharge ...	2·2	—	[illegible]

Expenditure on production constitutes only 15·4 per cent of the total and on debt discharge 1·1 per cent. We have not gone into the details of the expenditure on production side, but the holdings being small and the fields being mostly self-cultivated, the main items of expenditure are manure and seed. Any increase on the expenditure on these items will probably more than repay itself.

It is generally believed that the limiting factor as regards the cultivator's standard of living is the size of the holdings. Discussing the matter with cultivators having average-sized fields, namely 3·5 acres for a family of 5 consisting of man, woman and three children, one is surprised to find that with the present methods of cultivation, the peasant is unable to manage larger fields without regularly employing farm labour. With his present small holdings he has to employ labour for short time only when his programme is overcrowded and this cannot be helped. He could probably manage somewhat larger fields with the help of neighbours with mutual adjustment of crop rotation, but this involves a number of complications. For instance, the area allotted by the Government for jute cultivation cannot be left over to the next year nor double that area can be put under jute in alternate years. Thus the neighbours are busy with the same type of work at the same time and cannot co-operate with each other to any appreciable extent. Besides, as far as we were able to ascertain, the average acreage available, which is also the area the peasant is able to cultivate without outside help, is uneconomical and unless a supplementary occupation, which he may carry out during lax season or which the women folk may take up regularly, debts have to be incurred normally and more so when circumstances are adverse. It is, therefore, not surprising that over 40 per cent of the families are unable to balance their budget. What might be done to increase his capacity to cultivate larger holdings without farm labour we are not in a position to say but it would appear that wise guidance could, to a certain extent, save his labour and time in various ways. For instance, the present method of lifting water by means of 'dongi' or 'soonti' is very wasteful. Much time and labour could be saved by introducing Persian wheels. Wiser management may also save time now spent in removing weeds. Time and labour thus saved could be made available for other economic pursuits.

Reverting to the discussion of relative expenditure on various items, apart from debt discharge and production expenditure, it is obvious that food constitutes major part of it, leaving only a small amount (13 per cent) for other items. Of these clothing and fuel and light constitute 9 per cent and medical advice and medicines another 1·5 per cent, leaving only 2·7 per cent for all other amenities, including travelling, education, house rent, furniture, toilet, ceremonies etc. Thus important as education is, it has been relegated to a very minor position in the family budget, claiming as it does only 0·6 per cent of consumption expenditure.

We have given an overall picture in the previous paragraph. But distribution of wealth is uneven and the plight of the poorer classes must necessarily be even less satisfactory. Analysis has been made of the amounts spent on various items in families of different prosperity indices. This analysis is complicated because two factors *viz.*, the level of consumption expenditure and stability are involved. Comparing families of like stability as for instance those that just balance their budget it is found that expenditure on food diminishes for the poor families quite considerably but proportionate expenditure slightly increases. The same is true for clothing. Proportionately house rent remains practically unchanged and consequently it falls more heavily on the poorest families. The reason for this anomaly may be that the richer people own their houses. While the actual amount spent on furniture declines with poverty, the proportionate expenditure remains constant for the three classes. This is, however, a small item for all of them. The most striking example of progressively low expenditure both actual and proportionate is in respect of education and also for medical care except for a higher proportionate expenditure amongst the middle class. The well-to-do spend a little more money on ceremonies but the differences are not so marked as one might have expected. While the lower and higher classes spend proportionately the same amount on toilet material, no expenditure under this head is recorded for the middle-class families which probably arises from chance variation. Expenses not included under these heads are small and they are proportionately the same for all the classes.

The variations arising out of stability are fairly pronounced and uniform for the three classes for certain items. Thus relative expenditure on food increases for families which are running into debt. It is because of living beyond their means, in the matter of food, that they largely incur the debt. This again is an evidence of the fact that food requirements are not fully satisfied, even in the upper class families. No differences in the proportionate expenditure on education are seen in the upper class, but in the middle and the lower classes less stable families as a rule incur lower expenditure. Thus the axe readily falls on educational expenditure in lower class families when debt is incurred but the upper class would appear to be education conscious.

On the other hand, no regular trend can be observed in expenditure under medical head in any

class and this would suggest that it is only when an urgent need arises that money is spent for treatment. There is also not much regularity in the matter of travelling expenses but the more solvent families spend the largest amount on this item. The same is true for expenditure on ceremonies. Other items do not show any definite trends.

We do not know of a corresponding study of a rural population which may serve for purposes of comparison. The Indian studies mostly relate to industrial workers or other organized labour which are not on all fours in their economic circumstances with the community under investigation. Besides actual income, its real value and differences in needs arising from time and place, introduce complications. The present study relates to a time of stress when even though this particular community was not actually in the grip of the great Bengal Famine prevailing at the time in most parts of the province, it was not free from its evil effects. The items of expenditure though more or less similar may not bear exactly the same meaning. Moreover, the relative demands of various items may not be the same in different circumstances *e g.*, house rent would be far less in value in a rural area for similar or better accommodation than in towns or even in industrial slums. In most instances the labourers do not or cannot live with their families, unless there is attractive enough work for women also.

However, comparing the results of studies on labours in Kolar Goldfields[5], working class families in Alagappa Textiles (Cochin State),[6] landless agricultural labourers in a Berar village and Bombay working class[8], it has been noticed that except for the landless agricultural labour of Berar the proportionate expenditure on food is much too high for the Singur community. Clothing, on the other hand, is relatively a smaller item of expenditure in this community than in others, with the exception of workers in Kolar Goldfields, where the heat in the mines will permit the use of little clothing. The Berar agricultural labourer spends a pretty large part of his money on clothes. As regards expenditure on education, information is lacking for most communities but it would appear that unlike the Singur Villager the Kolar miner spends not an inconsiderable proportion of his income, under this head. He also manages to pay a good part of his income in debt discharge.

Allen and Bowley[9] have devised methods to distinguish between what, under the circumstances of the community, may constitute necessities and what may constitute, luxuries. Following one of their methods the regression equations of the various items on consumption expenditure have been worked out and are given in table II.

TABLE II

STRAIGHT LINE REGRESSION FOR EACH ITEMS OF EXPENDITURE ON TOTAL CONSUMPTION EXPENDITURE

Y = Expenditure on any particular item.
X = Total Expenditure on Consumption.

Items of expenditure	Regression equation on Consumption Expenditure
Food ...	Y = 0·7745X + 14·486
Fuel & Light ...	Y = 0·0271X − 0·678
House rent or tax ...	Y = 0·0009X + 0·293
Clothing, bedding and footwear ...	Y = 0·0520X + 7·782
Toilets ...	Y = 0·0026X − 0·058
Furniture ...	Y = 0·0011X − 0·418
Education ...	Y = 0·0090X − 8·324
Medical advice ...	Y = 0·0189X − 1·224
Travelling ...	Y = 0·0375X − 5·215
Ceremonies ...	Y = 0·0213X − 3·266

An item is termed a necessity if the proportion spent on that item decreases when the total expenditure increases and a luxury if the proportion increases. Thus positive figures for the constant in the regression equations mean necessities and negative values indicate luxuries. In the community under study, the necessities include food, house rent and clothing, while the remaining items constitute luxuries.

The same argument may be extended to distinguish between items of necessities and items of luxuries, amongst the various items of expenditure on food. The relevant regression equations are given in table III.

TABLE III

STRAIGHT LINE REGRESSION FOR VARIOUS ITEMS OF FOOD ON TOTAL EXPENDITURE ON FOOD

Y = Expenditure on the particular item
X = Total Expenditure on food.

Items of expenditure	Regression equations on the total expenditure on food.
Cereals ...	Y = 0·3804X + 9·970
Pulses ...	Y = 0·0461X + 0·085
Milk & curds ...	Y = 0·0977X − 7·634
Salt & spices ...	Y = 0·0196X + 1·263
Sugar & sweet ...	Y = 0·0373X − 0·995
Butter, ghee & oil ...	Y = 0·0430X + 1·251
Meat, fish & egg ...	Y = 0·0530X + 2·510
Vegetables ...	Y = 0·0937X − 0·329
Other food stuffs ...	Y = 0·0205X + 1·108

Only five items *viz.*, cereals, pulses, salt and spices, butter, ghee and oil, and meat, fish and egg constitute necessities while others like milk and curd, sugar and sweet and vegetables, fall under the category of luxuries. Miscellaneous items not in-

cluded in these items also constitute necessities. We venture to suggest that this analysis gives considerable insight into the standard of living of the community.

Another estimate of the standard of living is furnished by the determination of urgencies, that is to say, an estimate of the pent-up needs of the community as the people see it. To put it in other words urgent items are the ones on which they will prefer to spend more money. The order of urgency of various items of expenditure is measured by the difference between the average proportion of the total expenditure spent on any particular item and the rate at which the expenditure on that item varies for each unit of increase in total expenditure. In symbols it is given by w-k where $w=x/y$, in which x is the average expenditure on the particular item and y the total average expenditure and k the straight line regression co-efficient of y or x. The values of the difference w-k, for various items against total expenditure on consumption side are set out in Table IV.

TABLE IV

COEFFICIENT OF URGENCY FOR DIFFERENT ITEMS OF CONSUMPTION

Items of expenditure	Co-efficient of order of urgency
Food	·095
Clothing	014
House rent or tax	·001
Furniture	·001
Medical advice and Medicine ..	·001
Toilets	-·001
Education ...	-·003
Fuel & light ...	-·004
Ceremonies	-·019
Travelling	-031

It would thus seen that medical advice, education, fuel and light, ceremonies, and travelling are not considered so urgent as food, clothing, and house tax. In other words, the primary needs *viz.*, food, clothing and shelter, remain unsatisfied, and the interests which any civilized community would aspire to cultivate must, be relegated to the distant background. Similar analysis has been worked out for the various items of food, against total expenditure on food. They are also arranged according to urgency in Table V.

It is interesting to note that fish and meat occupy a position of considerable priority but milk and curds are the last to be thought of, not because they are available in plenty (in fact more than half the pre-school children get no milk at all and 39 per cent receive less than 10 oz. a day) but because at the moment they are out of reach and even other items,

TABLE V

CO-EFFICIENT OF URGENCY FOR DIFFERENT ITEMS OF FOOD ON TOTAL EXPENDITURE ON FOOD

Items of food	Co-efficient of order of urgency
Cereals	·21
Meat, fish & egg	·013
Salt and spices	·007
Other foodstuffs ..	·006
Butter, ghee, oil	·006
Pulse	·003
Vegetables	-·003
Sugar & sweets	-·008
Milk and curds	-·037

more urgently required, are not available to the extent desired. Milk and milk products constitute an important source of income required to meet expenditure on necessities.

We have already drawn attention to the considerable amount of variation in consumption expenditure found in different families. However, it would be of interest to see which items of expenditure vary more than others (see Table VI) from family to family.

TABLE VI

CO-EFFICIENT OF VARIATION FOR THE MAIN ITEMS OF CONSUMPTION EXPENDITURE

Items of expenditure	Co-efficient of variation
Food	37
Clothing, bedding, footwear ..	54
House rent or tax	78
Fuel & light	103
Medical advice and medicine ..	137
Toilet	162
Travelling	180
Ceremonies ...	214
Education ..	241
Furniture	246

The largest amount of variation is to be seen in furniture, education and ceremonies and the least on food. Clothing and house rent also show relatively small fluctuations. The variation in items such as fuel and light, medical advice, toilet and travelling, is moderate.

The amount of dispersion for different items of food are shown in Table VII.

As might be expected, cereals show the least variation. Salt and spices, pulses, vegetables, butter, ghee and oil and meat, fish and egg show moderate variation. The greatest variation is shown in the expenditure on milk and curd, and sugar and sweets.

TABLE VII

COEFFICIENT OF VARIATION FOR EXPENDITURES ON DIFFERENT ITEMS OF FOOD

Items of food	Co-efficient of variation
Cereals	33
Salt	56
Pulses	69
Vegetables	69
Butter, ghee and oil	70
Meat, fish and egg	73
Other foodstuffs	88
Sugar and sweets	112
Milk and curd	118

In other words, these luxuries are indulged in by relatively a small number of well-to-do families.

SUMMARY

Public health being an integral part of the social conditions of a community it must necessarily be studied against the general social background. The present communication deals with the economic position of the community in the Singur Health Centre Area as a part of the study of the Health conditions. The study is mainly confined to a discussion of family budgets and to the directions in which economic needs are most urgently felt. In appreciating the results of our findings it must be remembered that at the time of investigation Bengal was in the grip of a serious and widespread famine. While the area under investigation was not subjected to the full force of famine conditions till after the survey had been completed, it did exhibit certain amount of unusual stress. The average annual total *per capita* expenditure was Rs. 165/- and the index number of wholesale prices was roughly 240. Only about 15 per cent of it went to meet expenses in connection with production of commodities. The rest, which constituted the major portion, was applied towards the items of consumption including 1 per cent on debt discharge. Even at this low standard of life 40 per cent of the families were unable to balance their budget.

Food constituted the main item of expenditure being 73 per cent of the total expenditure or 87 per cent of the consumption expenditure. Of the remaining items clothings, fuel and light, and medical care took away nearly 10 per cent leaving only about 3 per cent for all the other amenities. Thus important items like education, were relegated to very minor positions claiming only 0·6 per cent of consumption expenditure between them. Comparing the proportionate amounts of money spent on different items among families of various prosperity levels, it was found that actual expenditure on food and clothing diminished with poverty but the proportion spent on them increased. On the other hand for medical care and education, the actual as well as the proportionate expenditure decreased. The proportionate expenditure for other items did not show significant variation among families of different relative prosperity. Comparing the present study with other Indian studies, the chief features of the Singur community, are the large proportion of expenditure on food and the small proportion spent on clothing. Following the method of Allen and Bowley, the items of expenditure which constitute necessities for the community were food, clothing and house rent, the rest were luxuries. Among items of food, cereals, pulses, salt and spices, butter, ghee and oil and meat, fish and egg constituted necessities and the rest luxuries. Again the most urgent items of expenditure for the community were food, clothing and house rent and the least urgent were travelling and ceremonies. Of the items of food the most urgent were cereals, meat, fish and egg, and salt and spices and the least urgent were milk and curds and sugar and sweets. The most variable items of expenditure as between families were furniture and education and the least variable were food and clothing. Similarly, of the items of food, milk and curd varied most and cereals and salt were the least variable.

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THEORY OF FRAGMENTATION OF CHROMOSOMES AND EVOLUTION OF SPECIES

A. K. CHAKRAVORTI

DEPARTMENT OF BOTANY, CALCUTTA UNIVERSITY

THE possibility of increase of chromosome number by fragmentation in plants was first suggested by Gates (1915). This concept though simple and straightforward in explaining certain aneuploid numbers in closely related species, still remained unacceptable by most of the contemporary cytologists on the ground that a fragment of a chromosome without an attachment constriction cannot survive (Navashin, 1932; Mather and Stone, 1933; Longley, 1941). In the light of some recent observations the problem has come up to the forefront for serious reconsideration. Thus, Bhaduri and Bose (1947) have claimed that the aneuploid numbers in different species of Cucurbitaceae cannot be explained on the basis of polyploidy and hybridization and that they can reasonably be explained on the basis of fragmentation of particular chromosomes across secondary constrictions. They have given definite evidence to prove that species like *Cucumis sativa* (n = 14) has given rise to species like *C. melo* (n = 21) through fragmentation at secondary constriction regions of particular chromosomes. Wilkinson (1944) while discussing the cyto-taxonomical problem in the genus *Salix*, observed that there are two basic numbers in the genus, 19 and 22. From a critical analysis of the chromosomes, he came to the conclusion that the number 22 is not aneuploid in the strict sense of the term, but has arisen from the 19-chromosomed types through fragmentation of some particular chromosomes across the secondary constrictions. In the light of the above observations and those made during the course of a cyto-genetical investigation in the group Scitamineae, together with the scattered evidence put forward by a number of investigators from time to time (Delaunay, 1926; Darlington, 1929, 1930; Kollar, 1932; Mather, 1932; Bhaduri, 1944; Müntzing, 1945), it now appears that, apart from polyploidy and hybridization, fragmentation of chromosomes has undoubtedly been responsible for the increase of chromosome number and subsequent alteration of karyotypes in many plant species.

Critical analysis of the somatic chromosomes of quite a large number of species and varieties belonging to the families, Musaceae, Zingiberaceae and Cannaceae, besides bringing out certain interesting features, which will be discussed elsewhere, corroborates the above contention. The striking differences with regard to both number and morphology of chromosomes of some allied genera and species do not lend any evidence in favour of the occurrence of polyploidy or hybridization in them. Neither the karyotypes nor the meiotic behaviour of the chromosomes in these plants show any indication of multiplication of sets of chromosomes or duplication of individual members of a set. Such differences can, however, be conveniently explained on the assumption of fragmentation across definite loci of particular chromosomes. The contrasting cytological features of hypothetical parental forms on the one hand, and their corresponding derivatives on the other, are given in table I.

TABLE I

SHOWING THE CONTRASTING CYTOLOGICAL FEATURES BETWEEN THE HYPOTHETICAL PARENTAL FORMS AND THEIR CORRESPONDING DERIVATIVES

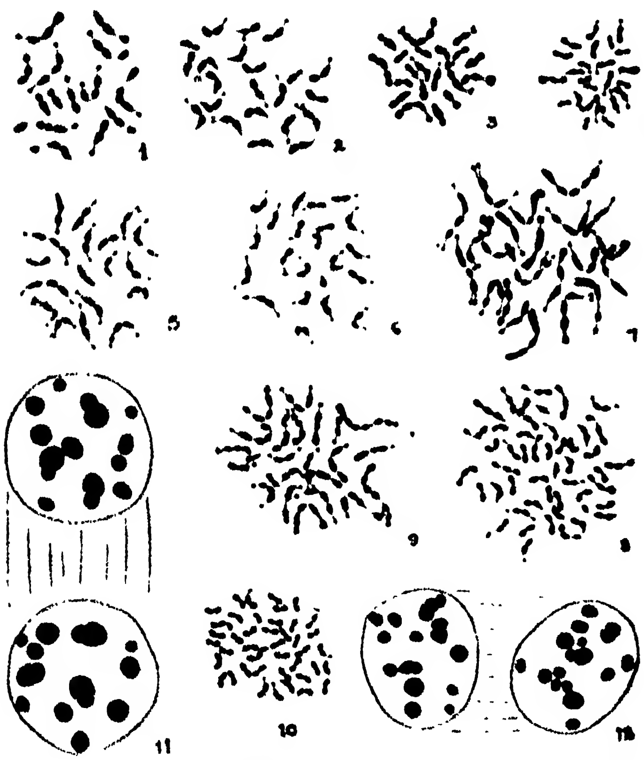
Parental Forms	Derived Forms
1. Lower number of chromosomes	Higher number of chromosomes.
2. Longer chromosomes	Shorter chromosomes. The sum total of lengths of all the members fairly corresponds to that of the parental forms.
3. Presence of larger number of nucleolar constrictions, either in the form of typical secondary constrictions or satellites. Many of such constrictions are supernumerary in nature.	Presence of smaller number of typical nucleolar constrictions and supernumerary constrictions. The number is proportionate to the number of assumed breaks across the secondary constrictions.
4. Absence of chromosomes with nucleolar constrictions in the form of secondary constriction-threads alone at their ends.	Presence of such chromosomes; the number is proportional to the assumed loci of breaks.
5. Smaller number of nucleoli.	Larger number of nucleoli. The increased number is proportional to the assumed number of breaks.

Specific cases having the above contrasting cytological features shown in table I are presented in table II.

TABLE II

SHOWING SPECIFIC CASES OF PARENTAL AND DERIVED FORMS ON THE THEORY OF FRAGMENTATION

Parental Forms	Derived Forms
1. 14-chromosomed species of *Strelitzia*, like *S. Reginae* (2n 14), Fam Musaceae, Fig 1.	22-chromosomed species of *Strelitzia*, like *S augusta* (2n 22), Fig. 2.
2. 22-chromosomed species of *Heliconia*, like *H. metallica* (2n 22), Fam. Musaceae, Fig. 3	24-chromosomed species of *Heliconia*, like *H. brasiliensis* (2n 24), Fig 4.
3 18-chromosomed species of *Musa*, like *M. superba* (2n 18), Fam Musaceae, Fig 5	22-chromosomed species of *Musa*, like *M paradisiaca*, sub-sp. *sapientum* (2n = 22), Fig 6
4 22 chromosomed species of *Zingiber*, like *Z cassumunar*, *Z. rubens*, *Z officinale* etc., Fam Zingiberaceae, Fig 7	48 chromosomed species of *Alpinia*, like *A. allughas*, *A bracteata*, *A nutans* etc., Fam Zingiberaceae, Fig. 8.
5 22-chromosomed species of *Kaempferia*, like *K atrovirens* (2n 22), Fam Zingiberceae, Fig. 9	42-chromosomed species of *Curcuma*, like *C. aromatica*, *C. amada*, *C. angustifolia*, etc., Fam. Zingiberaceae, Fig. 10.



Text figs. 1—10. Somatic metaphase plates Fig. 1. *Strelitzia Reginae* (2n = 14); Fig. 2. *S. augusta* (2n = 22); Fig. 3. *Heliconia metallica* (2n 22), Fig. 4. *H. brasiliensis* (2n = 24), Fig. 5. *Musa superba* (2n = 18); Fig. 6. *M. paradisiaca*, sub-sp. *sapientum* (2n 22), Fig. 7 *Zingiber rubens* (2n = 22); Fig 8 *Alpinia bracteata* (2n 48); Fig 9. *Kaempferia atrovirens* (2n 22); Fig. 10. *Curcuma angustifolia* (2n = 42); Fig. 11. Dyad nuclei of *M. superba* with nucleoli (15+15=30); Fig. 12. Same in *M. paradisiaca*, sub-sp. *sapientum* showing 17+17 34 nucleoli. Note the long chromosomes with supernumerary constrictions in figs. 1, 3, 5, 7 and 9 and the absence of such chromosomes from figs. 2, 4, 6, 8 and 10. Note chromosomes with drawn-off ends in figs. 2, 4, 6, 8 and 10 Figs 1 to 10. ×1000. Figs. 11 and 12. ×900.

In the genus *Musa* we find that *M. superba* has 2n = 18 chromosomes while the well known seeded varieties of *M. paradisiaca*, sub-sp. *sapientum* have all 2n = 22 chromosomes. The somatic chromosomes of the former species (*cf.* fig. 5) have been classified into 4 morphologically distinguishable types, namely, (I) 2 pairs of long chromosomes each with 3 secondary constrictions, two on the longer arm and one on the shorter, (II) 3 pairs of medium-sized chromosomes each with satellites at either ends, (III) 3 pairs of medium-sized chromosomes each having a satellite at one end only, and (IV) a pair of short chromosomes without any nucleolar constriction (figs 5 and 13a). The complement of 22 chromosomes of one of the varieties of *M. paradisiaca* procured from Balugaon, Orissa (figs. 6 and 14), has all the last 3 types of chromosomes referred to above and the number of each type exactly corresponds to that found in *M. superba*, excepting type (III) which, however, is represented by 5 pairs instead of 3 as found in the latter species. The first type of chromosomes of *M. superba* on the other hand, is missing from the karyotype of *M. paradisiaca*. But instead, the latter species shows the presence of 2 pairs of (I') chromosomes characterized in having one end being 'drawn-off into a fine chromatic process resembling a secondary constriction thread and a satellite at the other. The appearance of this type of chromosome and the increase in the number of the type (III) as referred to above in the somatic complement of *M. paradisiaca* can best be explained if we assume fragmentation across the proximal secondary constrictions on the longer arm of chromosomes (I) of *M. superba* as shown in figure 13a (*cf.* also Bhaduri, 1942a). Such fragmentaiton will result in 4 pairs of chromosomes, 2 of which will exactly

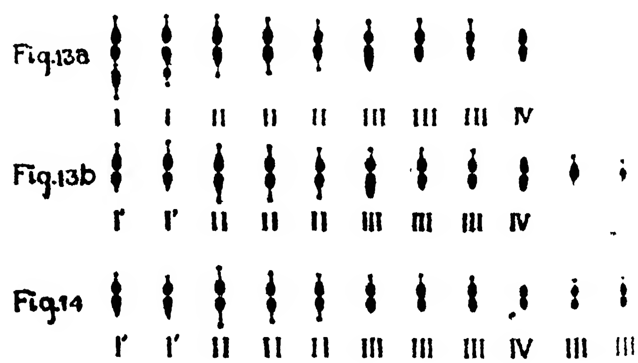


Fig. 13a. Idiogram of *M. superba* (n = 9). The loci of fragmentation on two (I) chromosomes have been represented by transverse bars. Fig. 13b. The same after fragmentation (n = 11). Fig 14. Idiogram of *M. paradisiaca* sub-sp. *sapientum* (n = 11). Compare the (I') chromosomes with those in Fig. 13b. ×1500 (approx.).

... mble type (I') of *M. paradisiaca* and the other which are acentric will have a satellite at one end ... a piece of secondary constriction thread at the other (*cf.* fig. 13b). But such chromosomes in order to perpetuate must develop kinetic body anew in which case they too will be similar in morphology to that of (I'). The type (I') differs from type (III), only in having a piece of secondary constriction thread at one of its ends. The number of these types of chromosomes will however, vary in accordance with the loci of break on the secondary constriction. If the breakage takes place at one extreme point on the constriction thread the result will be one chromosome of each of the types (I') and (III); if on the other hand, the break is somewhere at the middle of the thread as shown in ... 13a, then both the resulting chromosomes will be of the type (I'). The number of (I') chromosomes will, thus, vary between 4 and 8 and that of (III) between nil and 4 depending on the loci of breaks. If there are only 4 (I') chromosomes, there should also be 4 more of the type (III) in the derived form, over and above the number already present in the parental form. *M. superba* has no chromosome of the type (I') and has 3 pairs of type (III). The variety of *M. paradisiaca* which has been examined shows the presence of 2 pairs of (I') and ... pairs of the type (III) in its somatic complement (figs. 6 and 14).

Evidence of fragmentation of chromosomes as envisaged above in deriving *M. paradisiaca* from *M. superba* has also been obtained from a study of chromosome-nucleolus relationship in them. From the foregoing description of the karyotype of *M. superba* it will appear that there are altogether 30 nucleolar constrictions. Corresponding to this the maximum number of nucleoli in this species has been determined from dyad nuclei of PMC to be 30 (fig. 11). Fragmentation of the 2 pairs of (I) chromosomes of *M. superba* across the region of secondary constriction, is expected to increase the maximum number of nucleoli by the number of secondary constrictions undergoing breaks, *i.e.*, the number will be increased by 4 because all the 8 resulting fragments or new chromosomes will each retain the power of organizing a nucleolus from that end bearing a piece of secondary constriction thread alone, over and above the one developing from the other end having a typical satellite (*cf.* also Bhaduri and Bose, 1947). *M. Paradisiaca* has actually shown 34 nucleoli in the dyad nuclei of PMC (fig. 12). Such observation not only suggests that fragmentation of particular chromosomes across secondary constrictions has been responsible for the origin of 22 chromosomed species from 18-chromosomed ones of *Musa*, but also indicates that chromosomes or fragments originating as a result of fragmentation across secondary constriction are still capable of organizing nucleolus by virtue of the presence of a piece of secondary constriction thread. It also provides an explanation, apart from hitherto known methods like polyploidy (Gates, 1930, 1042) and non-homologous interchange of segments between nucleolar and non-nucleolar chromosomes (McClintock, 1934; Bhaduri, 1942a and b), for the increase in the number of nucleoli in a plant species (Bhaduri and Bose, 1947).

It is interesting to note that all the hypothetical parental forms so far studied are characterized in having an unusually large number of secondary constrictions, sometimes even much larger than their respective chromosome numbers. The significance of the presence of such high number of secondary constrictions, is that they provide loci of future breaks. The plants which have been found to give rise to new species through fragmentation of some of their chromosomes, may thus be considered as labile species, capable of throwing out new species spontaneously (*cf.* Bhaduri and Bose, 1947). The significance of such fragmentation may be attributed to the possibility of producing all the four spores with new combination of characters as against two, produced by the process of crossing over between two homologous chromatids only. Further, random distribution of chromosomes of the new complement resulting from fragmentation, will lead to various new combination of characters without, however, precluding the effect of crossing over. It thus appears that the process of fragmentation followed by a recombination of chromosomes can bring about revolutionary changes in the characters of a species

Turning to the problem of acquiring a centromere by an acentric fragment, there is at present, no direct evidence in its favour. Attention to certain recent observations may, however, be drawn. Darlington (1939, 1940) while explaining the origin of iso-chromosomes assumed that each of the two telomitic fragments resulting from a misdivision of the centromere, is capable of organizing a full centromere by the development of a few "centrogenes" The peculiar behavior of the "T-chromosomes" ("T-effect") in some inbred rye studied by Kattermann (1939), Prakken and Müntzing (1942), Ostergren (1945a and b) and Ostergren and Prakken (1946) suggests that in addition to the normal submedian centromere there is another particle at the end of the shorter arm ("T-arm") whose spindle reaction is similar to that of a normal centromere. Such manifestation of T-effect was observed in all the chromosomes of a special strain of rye (Ostergren and Prakken, 1946). Prakken and Müntzing (1942) pointed out that the T-end in spite of showing similar reaction to spindle like that of a normal cen-

tromere, differed from the latter in certain important properties. They concluded that the active component of a T-end could not be considered as simply a translocated centromere. In view of such conclusion, Ostergren and Prakken (1946) were inclined to believe that the phenomenon of T-effect is the result of the "interaction of two different causes, *viz.*, a special structural differentiation in this chromosome end, and a special genotypically and environmentally controlled physical condition in the cell".

It thus appears that under certain physiological conditions of nuclei, centromere-like particle may differentiate anew on the body of an acentric fragment. What are these conditions and how they operate in the process have yet to be determined by future researches.

In conclusion, I wish to express my thanks to Dr P. N. Bhaduri for kindly suggesting the problem, and for help and encouragement I received from him during the course of this investigation.

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DEVELOPMENTS IN ENGINEERING SEISMOLOGY

S. K. GHASWALA

BOMBAY

INTRODUCTION

THE science of Seismology named from the Greek *Seismos*, an earthquake, and *logos*, a discourse, in its simplest form means the study of earthquakes and all other allied phenomena of earth movements. During the dark ages these tectonic movements were regarded as the work of some evil spirits and awe and fear were associated with the occurrence of the phenomena. As the veil of darkness receded and the rays of civilization streamed through the human mantle, this latent inborn fear slowly went on decreasing, till the time when man by his intution and intelligence, was in a position to analyse scientifically the various phenomena of nature and give a rational explanation of their effects.

Earthquakes appear to have been diligently studied first by the Chinese some 2000 years ago, while their early records have also been mentioned in the Bible. In about 132 A.D. Chand Heng devised a contrivance to record earthquakes. This machine had eight dragons placed on delicate springs around a bowl, in the centre of which squatted a toad with open mouth. Each dragon held a ball made of copper in its mouth, so that when there was an earthquake the dragon nearest its source dropped its ball into the mouth of the toad. Crude, inefficient and primeval as it was, this mechanism can be looked upon as the forerunner of the present day delicate seismographs. Of the various types of vibrations, both natural and artificial, probably none excel in intensity and destructiveness, the natural ground vibrations in the form of earthquakes—transformations which change man's grandeur into nature's dust. The most active seismic regions of the world lie on belts about the Pacific, with an offshoot zone across Asia and Europe, north of India, along the north shore of the Mediterranean and running north and south through the relatively shoal waters of the mid-Atlantic. Examples of these seismic disturbances are known to many and will not be elaborated here. Actual figures however may convey a very vivid idea of the colossal destruction wrought by these occurrences. Thus in the last great earthquake of Bihar, India, in January 1934, when the shock lasted for five minutes and was felt over an area of 1,900,000 square miles, about 900 miles of railway lines were destroyed, 361 bridges were damaged and two million acres of cultivable land were affected. In the great Quetta earthquake of May 1935 more than 60,000 people died in Quetta alone, while property worth crores now lies buried under the debris. Similarly

in the great American Long Reach earthquake of March 1933, the damage amounted to 50 million, while in the Japanese earthquake of 1923 the loss reached the colossal figure of 550 million.[1, 2, 3]

General Aspects

The fundamental principles of seismic sciences have been described in many excellent books[1] and as such the writer has restricted his remarks only to those phases of Seismology which have either a bearing on, or are interconnected with engineering science, and which have not so far been collectively discussed in general texts on these subjects but are found scattered in English, European and American technical journals, not easily accessible to all.

The scientific study of earthquakes can be said to have started in the latter half of the 19th century, while an appreciation of its engineering aspects began some five decades later. Since then the domain of Engineering Seismology[4] has advanced considerably as is evident from the fact that the habitable parts of the earth now include almost all the seismic regions which formerly were but sparsely populated. Correct seismic data are equally important for an engineer as well as a geologist or a geophysicist. However, their actual needs are different. The latter aims to observe the different phases of seismic waves with a view to locate the origin of the earthquakes, to find their velocity of propagation and to study the internal structure and core of the earth. Such data have little direct value to an engineer, for he is mostly concerned not with the duration of preliminary tremors but with the intensity and nature of the principal motions of the destructive earthquakes. Contrasted with a geophysicist, to an engineer dealing with the dynamical theory as applied to the seismic design of tall buildings, the "time period", and "amplitude of vibration" required for evaluating the seismic acceleration in terms of the initial force of gravity 'g', are of immense value. Thus ordinary types of seismographs are entirely unsuited for recording the motion of severe earthquakes, directly on the site because they must be delicate enough to record far distant tremors. As a result of this situation, strong motion seismographs, vibrographs, and accelerographs have been developed to offer the engineer the best available data on strong tectonic movements. The determination of true ground motion by integration of strong motion records has been the subject of exhaustive investigation in recent times. The results of detailed work carried out by the U. S. Coast and Geodetic Survey in co-operation with the M. I. T. provide a very valuable compendium on the subject[5].

An internal disturbance in the earth caused by dynamic agencies gives rise to two types of waves involving longitudinal and transverse displacements in the solid. In Seismology these waves are referred to as the primary or P-type and the secondary or S-type of waves and together they constitute an earthquake. The earth which is not made up of one uniform material throughout, but consists of three stratified layers of different compositions, each layer being regarded as an isotropic spherical shell, eventually gives rise to waves of varying velocities. These velocities, which vary with the depth of continental layers have been closely investigated by Stoneley of Cambridge University.[6] If the depth of the origin of focus of an earthquake is such that the wave fronts are curved, the primary and secondary waves together generate at the free surface another two types of wave disturbances called the Rayleigh and Love waves. At the interfaces of the several layers these waves are further modified by reflection and refraction before they finally react on the foundations of the structure standing on the earth. In addition to these, there are waves formed by "deep focus" earthquakes which were first investigated in 1922 by Professor Turner, Savilian Professor of Astronomy, Oxford University and, later substantially studied and investigated by Richter, Wadati, Serase, Stoneley Escha and also by B. Gutenberg, the eminent seismologist of the Balch Graduate School of the Geological Sciences, California Institute of Technology, U. S. A. and Past President of the Seismological Society of America.[1] Deep focus records indicate that the body waves or transverse shocks are more prominent and at times the surface waves are even non-existent. The maximum foci of deep-focus earthquakes range from 60 to 440 miles and are limited to regions around Fiji, New Guinea to New Hebrides, East Indies and Phillippines, South America, and Japan and its vicinity. Further there is evidence to show that such deep focus seismic movements do not occur beneath those localities in which ordinary earthquakes are most frequent. The solution of the deep focus earthquake problems and their effects on engineering structures really demands knowledge of the state of matter in the earth's silicate mantle, a knowledge beyond the bounds of contemporary science.[7, 8]

From an engineering standpoint it can be stated that for regions near the earth's surface the primary waves may travel with an average speed of 4·7 miles per second and the secondary waves with a speed approximate 0·57 that of the P. waves *i.e.* 2·7 miles per sec. The periods of the corresponding vibrations may, for a near focus be as small as one second for the P. waves and two seconds for the S. types. The Rayleigh and Love waves, which make up the 3rd train, combine to form a very complex system of

oscillations which give the greatest amplitude for a given shock, by inducing an average velocity of 2 miles/sec. and a period of 40 to 60 seconds. The resultant disturbance, which alone is of interest to engineers, has a period of the order of one second, a wave length that lies between the limits of 5 and 40 miles and a minimum speed of about 2 miles/second. This tremendous velocity might well be compared with that of an ocean swell which travels at about 65 ft./second, *i.e.* 1/1650 of the speed of the resultant seismic wave. In the modern study of seismology, it is customary to draw a difference between "near" and "distant" earthquakes. Of these, the former is the more important and useful in the study of engineering problems, as considerable damage to structures is commonly associated with the surface movement due to "near" earthquakes. It thus becomes evident that in the study of these tectonic movements the data which is mainly of use in engineering cannot well be derived from records taken with the delicate seismographs used in geophysical work, on the transmission of stress waves originating at a distant source, as the destructive effect on structures especially buildings is more or less localised near the origin of the disturbance. According to Jeffreys[9] nearly all big earthquakes have focal depths rarely exceeding 22 miles and the most violently shaken areas are roughly confined to a radius of 13 miles.

Periods of Development

The developments in engineering seismology can be adequately reviewed by splitting up the entire field into six periods from 106 B.C. to 1755 A.D.; 1755-1880; 1880-1906; 1906-1923; 1923-1933 and 1933 to the present time. The first period from 106 B.C. to 1755 A.D. was not marked by any scientific activities or even evolution of the causes of earthquakes but represented a period during which for the first time in history a complete cataloguing of the earthquakes was carried out. Thus K. Von Hoff catalogued the earthquakes of the whole world from 106 B.C. to 1832 A.D., while Hoang prepared the same for China from 1767 B.C. to 1895 A.D.[1] In 1688 A.D. D. Vincengo Magnati,[10] Counsellor of the Holy Office of the City and Kingdom of Naples and Corrector and Officiating Priest of the Holy Royal House and of the Church of Santa Maria dal Popolo dell' Incurabili, gave out the causes of earthquakes as generated by wind, water, heat or by the concentration of bituminous matter. He appears to be the first to authentically denounce the fictitious causes as set forth by the early Mahommedans and by the Rabbis, and cast aside the superstitious beliefs of the Chaldeans, Babylonians, and Egyptians who attributed all tectonic movements to the natural progress of sun and stars in the Heavens. Magnati was also among the first to prepare a list of earthquakes from 34 A.D. to 1687 A.D., —a list whose authenticity has survived up to the present day.

The great Lisbon earthquake of 1755 marks the beginning of the second period as before this date little was correctly known about the tectonic movements, and although the Reverend John Mitchell contributed an essay on the subject of earth tremors in 1760, it was not until about 1846 that the first scientific treatment of the dynamics of earth was given. This pioneering work was done by Robert Mallet[11] who, in presenting his monumental work to the Royal Irish Academy laid the foundations of the theory and origin of earthquakes. For nearly 30 years, after Mallet's work few other investigators probed into the realms of Seismology, when in 1875, the distinguished English Scientist John Milne was invited by the Emperor of Japan to teach mining and geology, and who in 1880 formed the Seismological Society of Japan—the first scientific society of its type in the world. This forms the third period of seismic development. Together with other English, American and Japanese scientists, like Ewing, Ayrton, Knott, Mendenhall, Perry, Sekiya, and Omori, Milne contributed much towards the knowledge of earthquakes and their effects on structures. His most important experimental contribution was the development of the shaking table now recognised as a vital tool of research in all seismic problems connected with engineering design[12]. The work carried out during this period and the results formulated were accepted in America till about 1928 when the findings of research investigators with more refined technique especially since the establishment of the Vibration Laboratory at Stanford University, California (to be described later) began to cast doubts upon earlier results. Milne was also responsible for laying the foundations of a world wide net work of observations for earthquake records. His monumental work was continued after his death by Prof. Turner of Oxford University, so that Oxford became the international centre for the collection and dissemination of these records.

The great San Francisco earthquake of 1906 formed the fourth period of seismic activity. A few months after this disaster the well known Seismological Society of America (with which the author is connected) was established with the object of promoting research in Seismology, the scientific investigations of earthquakes, their geographical distribution, historical sequence, effects on buildings and related phenomena. This Society which is a corporation of the State of California, is administered by a Board of Directors, in co-operation with a Scientific

Council and an Editorial Committee—each eminent in his own respective branch of Seismology. Also at the beginning of this period a committee of leading experts on the subject and sponsored by the American Society of Civil Engineers, was set up to prepare a comprehensive report on this disaster, its causes, effects and the manner of maintaining structural integrity in buildings[13] Most of the conclusions drawn from this report are still regarded as essentially sound. One of the main results, however, relating to the equivalence of a wind force to resist all earth tremors has now been discredited for experimental and theoretical evidence has conclusively shown that by simply providing a high value of wind pressure it is not possible to produce earthquake-resisting structures[14].

For nearly 17 years after this great earthquake, progress remained practically at a standstill, till 1923, when on September 1, of that year, Engineers and Seismologists in particular, and the citizens of the whole world in general were awakened by the disastrous vibrations of the great Kwanto earthquake (also known as the Tokyo-Yokohama earthquake) which severely destroyed Tokyo and Yokohama and was within a month followed by no less than 1256 after-shocks. This formed the fifth period of development and resulted two years later in the establishment of the world renowned Earthquake Research Institute at the Tokyo Imperial University from where emanated some of the most authoritative and monumental works in Engineering Seismology[15]. During this period, engineers saw for the first time in history, the effects of a destructive earthquake on modern buildings of reinforced concrete and steel. Several investigations proceeded after this Japanese earthquake, during which the work of Naito and Kyoji Suyehiro in Japan and Martel in America had a profound influence on structural design in most of the countries prone to seismic activity[4]. The work of Prof. Martel at the California Institute of Technology represented then the only American experimental research in seismic design. The memorable and authoritative lectures on Engineering Seismology also delivered during this period (November and December 1931) by the late Dr Suyehiro, Director of the Earthquake Research Institute, Tokyo, and one of the greatest exponents of Seismology, at the California and the Stanford Universities, and California and Massachusetts Institutes of Technology, produced a profound effect on the American system, and in many ways led towards modifications in the then current trend of design[4]. In fact as far as the writer is aware Dr Naito was the first to realise that a horizontal force on a building with stiff floors is distributed among the structural elements of a building in proportion to their relative rigidities and not in proportion to wall areas, or column spacings. From these fundamental conceptions, two schools of thought developed on the seismic design of buildings, which were later on partially modified to run as a new tributary to the river of Engineering Seismology. One held to the principal of rigidity combined with strength as the essential factor, while the other held that sufficient strength and rigidity were difficult to attain practically and economically and as such advocated a highly flexible type of construction. The latter theory represented essentially the design of a building in which the first storey of a multi-storied building was made so flexible in relation to the stiffness of the other stories above, that the earthquake motion would be fully absorbed there only and little damage would be done to the whole structure. Today's conception of this flexible first storey building though not completely out of date is very different from that propounded in those early days. According to the results of studies carried out on models of buildings by Dr Lydik S. Jacobsen of Stanford University, California—one on the world's greatest authorities on Applied Seismology—a flexible first storey shields the superstructure against high frequency ground vibrations and is also very effective in shielding the higher modes of a large structure whose fundamental frequencies of vibration are outside the earthquake frequency range. However, a flexible first storey is neither necessary nor even advisable for a short building whose natural frequencies are relatively large[16]. In 1926, a vibration research laboratory was inaugurated at Stanford University, California, mainly through the efforts of Dr Bailey Willis, and Dr Jacobsen, Professor of Civil and Mechanical Engineering was put in charge. Since then this laboratory under the direct guidance of this outstanding authority has been considerably expanded through funds received from the National Academy of Sciences and the Research Corporation of New York, that it is now looked upon as the finest and the world's most perfect vibration research centre for all problems connected with Engineering Seismology. Most of the experimental work in undertaken by studying the behaviour of models of which two general types are in use: (*a*) the actual "scale" model which is capable of showing a structural failure directly and (*b*) the purely dynamic model which does not necessarily resemble the actual structure and which does not show any structural failures, but in which the observed dynamic distortions can be related to failure by computations. The behaviour of models are recorded in various ways such as direct recording on a chronograph drum, by high speed motion picture photography and by electric or magnetic strain gauges in connection with an oscillograph[17].

In 1927 Dr Perry Byerly, Seismologist of the University of California and Secretary of the Seismological Society of America undertook for the first time the measurement of the natural periods of vibration of a number of tall buildings in San Francisco, to arrive at some definite results for setting up some standard codes of correct structural practice. From this small beginning came the extensive programme of measurement carried out by the U.S. Coast and Geodetic Survey, which now functions as one of the leading bodies in disseminating seismic data. It is really remarkable that in spite of the many new developments that took place in America the major discussions on the seismic design of structures which took place at the World Engineering Congress at Tokyo, in 1929 revealed the fact that Japanese work on the subject was then far in advance of any other country both in theory and practice—and the world of Engineering Seismology accepted that country's work as representing the latest and the most authoritative thought of the times. Rigidity rather than flexibility was aimed at by Japanese engineers as their rigid buildings designed to withstand an acceleration of 1/20 to 1/10 of gravity 'g' with normal working stresses had survived the great 1923 earthquake without appreciable damage. During this period, Japan, was the leading country to pursue a programme of detailed study of underground seismic motions and length charges of the ground, as well as to carry out the construction of permanent Seismological stations inside railway tunnels to study the effects in such structures; to make continuous measurements of the variation in the derivatives of gravity potential, and of the tilting of ground by long water tubes, and to observe the effects of earthquakes on principal buildings of the country, by installing therein suitable strong motion recorders and strain meters. That Japan should contribute the largest and the most important share of knowledge in the relatively unexplored fields of Seismology is not surprising when it is known that, that country experiences on an average three earthquakes per day according to Prof. Jones F.R.S. the distinguished geophysicist of Cambridge[18].

The American Long Beach earthquake of March 1933, and the Bihar and Quetta earthquakes of 1934 and 1935 in India, forms the sixth and the last period in the chronological development, and also the beginning of the latest methods of theory and practice in Engineering Seismology. As damage after the Long Beach shock was appreciable, public sentiment was considerably roused to an extent whereby State Legislature was approached and the necessity of sound design, supervision and construction was enforced by law. Accelerographs, displacement meters, and seismographs were installed at strategic points throughout California and other Western States and periods of both natural and forced vibrations were determined for buildings, bridge piers, water tanks and dams. This period also brought about the development of several modes of correct practice for designing massive structures like dams, bridges and water towers in heavily active seismic belts. Thus three of the world's greatest American dams the Boulder, Grand Coulee and Shasta, designed by the U. S. Bureau of Reclamation, are situated on the most active earthquake zones. The contemplated dam on Kosi River in India, it may be mentioned, will also be constructed on a zone of comparatively high seismic activity. This opinion has been recently given by no less a person than Dr J. L. Savage, an internationally renowned authority and designer of the world's greatest dams, who is at present being consulted by the Government of India on its various hydro-dynamic projects. Important theoretical and experimental studies are being carried out on the design of earthquake resisting structures for dams, water tanks and towers in the Mass. Inst. of Tech., Stanford University, California and at other places by several investigators, like Ruge,[19] Jacobsen, Hoskins,[20] Westergaard,[21] Mead and Carder[22] which have enabled designers to extend their gradient of knowledge far beyond the limits of the last two decades.

As insurance plays an important part in dealing with structures in seismic zones, it is not surprising to learn that insurance firms have collected voluminous data, which serve at times as an index for gauging the engineering progress. Thus a very valid idea can be had at a glance from the table given below showing the losses sustained by various types of structures resting on firm natural ground, when subjected to the effects of an earthquake.

Type of Construction	Average expected loss percentage of sound value
Hollow Block or Hollow Tile Construction	75
Brick-veneered wood frame or concrete frame structures with hollow tile partitions	25
Ordinary well built brick bearing walls, factory buildings with strong wooden floors and roofs (not>4 stories) ..	8
Well built R.C.C. buildings without rivetted or welded steel frame with R.C.C curtain walls laid in good cement mortar (not>4 stories) ...	6
Steel frame R.C.C. buildings specifically designed to resist earthquakes (not over 100 ft. high)	3 and less

Present Conceptions

According to modern theories, an earthquake is ...ded as an oscillatory movement of the earth's ... and that structures standing on it are considered ...ve both mass and elasticity thereby rendering ...le the calculation of forces acting on various ...tural members. Detailed studies on these lines ... been carried out by Timoshenko, Wylis, ...sen, White and others in America, by Imamura, ...a and Kanai in Japan, and by Valenzuela in ... University of Chile. In fact in Chile, earth...e research which is carried out at the Institute ... Experimental Statics, is planned on the same ...as Stanford University, California, wherein full ... made of piezo electric cells and steel models. ... the guidance of its able director Julio ...nzuela[23] the Institute has evolved an analytical ...od of seismic design of structures, which, in ... opinion of Dr Jacobsen, is the most rational ...d available at present. Since 1936, a programme ...arthquake research sponsored by the Los Angeles ...ty Department of Building and Safety has been ...ucted at the Calif. Inst. of Tech. under the direc... of Professor Martel. The chief aim of this work ... development of satisfactory criteria for the ...of structures to resist earthquakes by carrying ... investigations on the characteristics of earth... especially the strong motion vibrations and ... deformations and stresses occurring in a struc... when subjected to the recorded ground motion. ... leads directly to a study of the vibrational charac...es of the structure together with the ground ... which it rests.[24]

The true analytical and experimental investiga... of earthquakes has begun very recently when ... data furnished by accelerograms (especially of ... motion waves) is used in conjunction with the ...ng Seismological knowledge. The modern con...n in all its complexities is to visualise the struc... question as floating on a medium in which ... irregular waves are propagating with attri... of distributed elasticity and damping effects, ...t like a ship in the ocean, its motion is depen... upon its own rigidity, mass and size relative to ... aves and is not completely synchronous with ... motion of the surrounding fluid. Further, inter... friction and yield point in the surrounding soil ... the final effects of reflected, refracted and ...gted waves on an agglomeration of buildings ... considerably modified by the individual structures ... an important effect on resonance phenomena, ...elves.

Earthquake Spectrum

The conception of an earthquake spectrum ...ing a basic analytical approach to the problem of seismic design of structures forms a very important and the latest method of tackling the varied aspects of earthquake effects. This conception was first put forward in its refined state by Prof. M. A. Biot of the California Institute of Technology[25] in 1932, and a cheap and simple operating mechanical analyser (consisting of a torsion pendulum with variable tuning whose point of suspension could be made to turn proportionally to the acceleration of the earthquakes), was later developed by him at Columbia University to avoid complicated numerical mathematical work.[26] It may be mentioned here that operational methods somewhat similar to those of Prof. Biot were originally evolved by Oliver Heaviside for studying the effects of transient electrical impulses, and can be extended by means of the theory of functions of a complex variable in analysing the effects of earthquake transients upon structures.[27, 28] The earthquake spectrum is a curve characteristic of a given earthquake which gives some kind of periodicity content by associating a certain acceleration intensity with a given period. The motion of the structure is considered as the superposition of its various modes of vibration and the maximum stress produced in each mode is made to depend on a coefficient characteristic of the structure termed the "effectiveness factor" and of that particular mode. The spectrum gives a direct measurement of the maximum shear in a building due to a given earthquake. This concept permits an easy comparison between various earthquakes and also between various types of structures or modes within these structures as to the stresses produced by a given earthquake. Applications of the concept of earthquake spectrum have been made by Martel, White, Hoff and Jacobsen[29] while the use of torsion pendulum analogous to the one used by Biot have been made by Savage to evaluate earthquake stresses in bridges.[30] The conceptions evolved through the earthquake spectrum have a bearing on other problems in engineering also such as explosion effects on buildings; impact of projectiles; the determination of dynamic effects of wind on static structures (like buildings, bridges and towers) and on dynamic structures (like aeroplanes and rockets) by the introduction of a spectrum of atmospheric turbulence.

A detailed study of earthquake spectra reveals many interesting and informative results for use in seismic design. An analysis of two American earthquakes-Helena, Mont, (Oct. 31, 1935) and Ferndale, California (Feb. 6, 1937) indicates, that an undamped structure with a period of approx. 0·2 second would undergo a horizontal shear equal to its own weight. This of course constitutes an upper limit because actually a number of stress-reducing factors enter into play, the most important being damping. During

minor earth tremors, damping effects may be very small, whereas in strong earthquakes they may be appreciable. When the amplitude of stress reaches the yield point in some part of a structure plastic deformation and friction will produce a high degree energy dissipation. Another stress reduction which has been observed is that due to the influence of the foundation. When oscillations are set up in a building strains are produced in the foundation and energy is dissipated by internal friction in the soil. The motion of the building also produces a radiation of the elastic waves into the soil, an effect which was first theoretically investigated by Sezava and Kanai.[31] Due to this effect the oscillatory energy is drained from the building through the foundation and radiated into the soil in the form of elastic waves. The elasticity of the foundation will also have an influence on the stresses, because it increases the natural period of vibration of buildings. In other words the building will not follow the horizontal motion of the ground but due to the elasticity of the foundation will tend to rock about at its centre of percussion. The problems of the influence of foundation, its yield and absorption, first investigated by Suyehiro and Ishimoto in 1926[32] are worthy of a detailed study. The earthquake spectrum has vividly brought to light another significant phenomenon referred to as the "whip" effect, which increases the destructiveness of earthquakes on penthouses and the tips of tapered columns and buildings. Considered from the standpoint of wave propagation it is analogous to what happens in a whip when a wave generated at the base is propagated to the tip. The wave forms as it were a lump of energy moving from the heavy part of the whip to the tip. This produces a concentration of energy at the tip, which being of a smaller mass than the base, results in a higher wave velocity. This is commonly associated with taper and explains for failure of propeller tips and tapered beams. Actual observations of failures of penthouses and long and tapered buildings during the Long Beach earthquake of March 1933 strikingly agree with the phenomena of "whip" effect. This analytical method of analysis by the spectrum requires to be further developed in order that a wider and deeper knowledge of the earthquake dynamics can be obtainable, such as the influence of foundation on the superstructure, the interference of structures with one another, the influence of agglomeration of earthquake waves themselves, and a detailed study of the effects of earth tremors on skyscrapers, about which practically very little is known today.

Seismic Sea Waves

The recent quake shocks and tidal wave in Japan (December 21, 1946) which according to the Tokio Meteorological Observatory was the hardest which ever hit Japan (even bigger than the great earthquake of 1923) vividly brings to light the importance of the subject of marine seismology. In this earthquake and tidal wave which swept the parts of Wakayama prefecture, the epicentre was some 100 miles South, South-west of Osaka and affected a pear shaped area 100 miles long and 60 miles wide.

In reality these tidal waves have actually nothing to do with the tides but arise either from submarine tremors, or earthquakes occurring near the coast, or submarine landslides or submarine volcanic action. In Japanese language they are called "Tsumani" and in Italian "Maremoto". When vertical displacements take place through some submarine activity, one side moves up and the other side moves down and water rushes into the depression brought about in this way. Thus the water is elevated on one side of the fault and depressed on the other and waves of corresponding magnitude are initiated on the surface of the ocean, with elevation leading on one side and depression on the other. According to Green's law for submarine disturbances not very far from a bay or coast the height of the wave is proportional to the product of $\frac{1}{b^2}$ and $\frac{1}{d^4}$ where 'b' is, the breadth and 'd' is the depth of water. Examples of steep slopes in combination with seismic sea waves up to 60 ft. and more in height are found on the coast of Peru and Chile, while on the coast of Sanriken, Japan, to the east of which lies Tuscarora Trough a depth of over 2900 ft. has been recorded. For a detailed study of seismic sea waves the report published by the Royal Society of London in 1888, on the eruption of Krakatoa is worthy of careful scrutiny. According to this report the missing volume of Mt. Krakatoa was at least 200,000 million cft., and 1/50th part of this mass suddenly dropping into the water would by its displacement alone furnish sufficient liquid to form a wave some 100 miles in circumference, 350 ft. wide and 20 ft. high. The actual wave was estimated to be 50 ft. high on the neighbouring shores of Sundra Strait and the undulations produced by it were so enormous that they were recorded at coast stations on all the 5 continents of the globe. Actually two types of waves were generated, (*i*) by the direct propagation due to volcanic eruption and (*ii*) stationary oscillations of distant bays, and inlets. Thus for example the records in India at Negapatam, Madras and Vizagapatam (distance 1805, 1863 and 1909 miles respectively from Krakatoa) enabled the progress of the waves to be traced as it advanced up the Bay of Bengal, since the tide gauge at these stations were situated on the open coast. From the standpoint of Engineering Seismology, these marine disturbances, have an im-

portant bearing on the design and construction of breakwaters, jetties, harbours and submarine cables, as well as on road bridges, buildings and railway tracks situated near the sea. The probable occurrence of seismic sea waves in a given locality and the effect of such waves on nearby structures to withstand the stresses developed, are subjects requiring a close investigation and study.

Conclusions

Seismology invites the co-operation of workers and thinkers in almost every branch of science, ranging from pure mathematics to practical engineering. Thus mathematicians are faced with many problems relating to the elasticity of solids, the wave motion propagated from a disturbance, the response of the instruments to applied oscillations of prescribed forms and to the solution of complex differential equations governing the vibrational aspects. To the astronomer, earthquakes are disturbances which occur on any planet and the information they give about the interior of the earth is of value towards a better knowledge of the compositions and conditions in other members of the solar system. Meteorologists are specially interested in the study of microseisms (omitted from the present discussion as they have no direct bearing on engineering) which are now believed to have a certain influence on weather and atmosphere in general and storms in particular as well as on the variations in atmospheric pressure which are regarded as trigger causes of earthquakes. To geographers and geologists the tectonic movements convey a considerable amount of knowledge on the subject of land and sea masses and the strength, structure and composition of the earth. To psychologists and students of natural history the earthquake furnishes a very rare and incalculable means of observing the reactions of earth tremors on human beings and lower animals while to the student of applied physics the development and construction of delicate seismic instruments and other devices to record the various types of earth's vibrating motions, form a subject of deep interest. Last but not the least are the engineers. In fact the whole civilised world in general and the inhabitants of seismic regions in particular, owe them a deep debt of gratitude for constructing structures which can be inhabited without risk to human life or property during earthquakes. It is the engineer who more than any one else comes face to face with the problems of practical design and construction of structures whose theoretical principles are propounded by mathematicians, seismologists and geophysicists. The co-operation of engineers is also sought by insurance companies to arrive at definite figures for fixing the premium and other rates to cover property against damage. It is thus evident that from small beginnings, the science of Engineering Seismology has advanced considerably and has contributed in no small measure to the gross happiness of mankind on this globe. As work in the allied fields of science and technology increases, the spectrum of Engineering Seismology will also continue to widen its sphere of activity.

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ON CERTAIN ECONOMIC POISONS

S. B. SENGUPTA,

STANDARD PHARMACEUTICAL WORKS LTD., CALCUTTA

THE control of the organisms which are harmful to plant life is, at present, a problem of major importance. Even though the soil and other conditions are favourable, the production of crop may considerably be impaired due to attacks of many harmful insects or other disease-producing organisms. In many cases, complete destruction of crops, has occurred as a result of insect attack. In India, losses of crop due to insects and diseases appear to be enormous and have been increasing from year to year.

Several methods have been used to reduce the population of pests in cultivated plants and the application of chemicals is the most important modern method used to control plant pests. By proper choice of insecticide, it is possible to control nearly all insects. In this article, a few synthetic organic compounds used as economic poisons will be described.

Pyrethrum, tobacco and rotenone-bearing plants such as *Derris and Lonchocarpus*, are the most important insecticidal plants. Of these, only tobacco is produced in our country in sufficient quantity. *Pyrethrum* plants are mainly grown in Formosa and Coastal China. *Derris* is available in British Malay and Dutch East Indies. *Lonchocarpus* is grown usually in tropical countries. During the war, these plants could not be obtained in sufficient quantity and need for synthetic insecticide was keenly felt. The insecticidal compounds containing lead, copper and arsenic could not be manufactured indiscriminately during the war, because of the demand of those metals in more essential war products. All these facts intensified the need for new chemicals for fighting the insect pests, which cause heavy damage to agricultural products.

In preparing a synthetic compound as insecticide, it is reasonable to choose the structure of known naturally occurring insecticides such as: nicotine, pyrethrin and rotenone as model. Unfortunately comparison of their structures reveals no common grouping to which insecticidal property may be attributed.

Consequently, chemists have been compelled to work by the method of trial and error.

Although nicotine, pyrethrin and rotenone have complicated structure, this is no reason for supposing that organic compounds must have large and complicated structure in order to be effective insecticides. The simple compounds such as hydrocynide, methyl bromide, D.D.T. and benzene hexachloride have been proved useful as insecticides.

D.D.T.—Few developments have created greater interest than the discovery by Müller[1] in Switzerland the insecticidal property of D.D.T. D.D.T. is prepared by condensing p-chlorobenzene and chloral-hydrate in concentrated sulphuric acid. This reaction produces essentially a mixture of two isomers- 1-trichloro-2,2, bis (p-chlorophenyl) ethane, called pp′ D.D.T. and 1-trichloro 2-0-chlorophenyl 2-p-chlorophenyl ethane called Op′D.D.T. in the ratio 3-4 parts of pp′D.D.T. to 1 part Op′D.D.T. with small amount of oo′D.D.T. [2,3].

The toxicity test of these different isomers on mosquito-larvae has shown that pp′D.D.T. is definitely the most effective isomer[4,5,6].

Since the discovery of D.D.T., many different compounds analogous to D.D.T. have been prepared in the laboratory to study their insecticidal properties. A group of compounds were prepared by replacing chlorine atom of ethane part of molecule by hydrogen and they are found to be comparatively less effective than pp′D.D.T. as mosquito larvicide[5,7]. The replacement of chlorine atom with bromine gives compounds which are considerably less active than pp′D.D.T. Another series of compounds were prepared by replacing chlorine atom of the benzene ring by bromine, hydrogen and methyl group and they are all found to be less effective than pp′D.D.T.[5]. The substitution of tert-butyl or hydroxyl group for chlorine atom gives compound which are of practically no value as insecticide and acetylation of hydroxyl group gives an inert compound.[5] By methylation of hydroxyl group, a compound was obtained which possesses a quick knock-down property[8], but its killing power is less than D.D.T.

Comparison of D.D.T. with Paris Green and *Pyrethrum*

Before the discovery of D.D.T., Paris Green was used to combat malaria carrying mosquito-larvae. It is low in cost; but it has the serious drawback that it breaks down in water to form soluble arsenic compound which has no action on larvae but is very much toxic to fish and plant life.

The comparative toxicities of Paris Green dust and pp′D.D.T. dust in talc on *Anopheles quadrimaculatus* have been studied and results are given below[9]:—

TABLE I

Talc Dust	Dosage-pound per acre	% mortality in 48 hrs.
pp′D.D.T.- ·01% ...	·005	100
	·0015	87
Paris Green- ·5% ...	·05	76
	·025	49

pp′D.D.T. is found to be far more effective than Paris Green in controlling mosquito larvae.

Pyrethrum is one of the oldest and popular insecticides used against mosquitoes and houseflies. Pyrethrum contains two active constituents—pyrethrin and cinerin[10]—which are responsible for the insecticidal property of pyrethrum. The comparative study of toxicities of pp′D.D.T. and pyrethrin on adult houseflies has been made[11] and results are given below:—

TABLE II

Compound	Concentration Milligram/c.c.	Mean mortality in 1 day	Mean concentration causing 50% mortality mg/c.c.
pp′D.D.T. ..	1·00	93%	0·5
	0·50	57%	
Pyrethrin ..	1·18	40%	1·4
	2·36	74%	

It appears that in comparison to pp′D.D.T., three times more pyrethrin are required to give 50 per cent mortality to adult mosquitoes.

Although D.D.T. is effective against wide variety of injurious insects than any of the organic insecticides tested so far, it has no effect on boll-weevil which causes serious damage every year. It has no effect on cotton leaf worm, cotton aphid, red spider, cattle grubs, sugarcane borers, orchard mites and others.

Benzene Hexachloride

Slade (March, 1945)[12] discovered that gamma isomer of benzene hexachloride possesses outstanding insecticidal property. The gamma isomer of hexachlorocyclohexane is one of the four isomers produced during chlorination of benzene in presence of light.

The four isomers are formed in the following proportions: *(i)* alpha up to 70 per cent., *(ii)* beta—5 per cent, *(iii)* gamma 10-12 per cent, *(iv)* delta 13-15 per cent. These isomers can be separated from

each other by fractional crystallization. The comparative toxicities of gamma isomer of benzene hexachloride, pp'D.D.T and pyrethrin to houseflies have been determined[13] and it has been found that for 50 per cent mortality, gamma benzene hexachloride is about 9 times as toxic as pp'D.D.T. and 18 times as toxic as pyrethrin. Benzene hexachloride is a powerful insecticide against numerous agricultural pests, notably, against boll weevil upon which pp'D.D.T. has no action. On the other hand, benzene hexachloride is ineffective against boll worm but pp'D.D.T. is very toxic to it. A special advantage of gamma benzene hexachloride is that it has high killing power for mites which are not killed by D.D.T.

Synergists

Eagleson[14] showed that addition of 1-5 per cent sesame oil to kerosene solution of pyrethrum increases appreciably its effectiveness against houseflies. Aerosol containing pyrethrum is usually mixed up with sesame oil. The synergistic property of sesame oil is due to a crystalline compound, sesamine[15]. A number of compounds similar to sesamine such as, Penoresinol, Eudesamin, Asarinin, have been isolated from plants, and their effect as synergist has been studied.

It was observed that pinoresinol dimethyl ether the optical antipode of eudesamin was without any synergistic action as were penoresinol and its compounds. It is therefore concluded that nature of substitution on benzene ring is an important factor in the synergistic action. This finding on the relation of constitution and synergistic action has opened up a now field of exploration and already a number of compounds prepared which possess synergistic property.

Repellant

Materials which have the power of repelling both biting and sucking insects are sometimes, used for plant protection. The role of repellant is mainly to protect anything from the attack of insects which cause damages. At Orlando laboratory, thousands of compounds were prepared and tested for their repellant properties. Most of the compounds are liquids.[7] There are a few solid compounds which have been found to possess good repellant property. These may be used as dust in protecting clothes. As the liquid form of repellant is suitable for rubbing on the skin, liquid compounds have been studied extensively for their repellant action.

Four repellants, (*i*) Dimethyl pthalate, (*ii*) N-butyl mesityl oxide (Indalone), (*iii*) 2-ethyl 1, 3 hexanediol (Rutger 612) and (*iv*) isopropyl cinnamate were recommended for use. The comparative repellant properties of these four compounds against *Aedes aegypti* and *Anopheles quadrimaculatus* are given below:—

TABLE III

Compounds	Average repellant time in minutes	
	Aedes aegypti	*Anopheles quadrimaculatus*
Dimethyl pthalate	258	108
Rutger 612	346	55
Indalone ..	147	41
Isopropyl Cinnamate	220	120

Although much progress has been made in the development of synthetic insecticide during the war in America, the search for better insecticide must continue because of its increasing demand in agriculture. The effect of an insecticide on beneficial pests and its toxicity to warm blooded animals especially to man, must be worked out before it is recommended for use. Obviously these require long and carefully controlled experiments to be carried out with the co-operation of chemists and entomologists. The establishment of a synthetic compound as a successful insecticide takes a long time. The subject of insecticide is gradually receiving more attention of scientific workers in this country.

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ALKALI INDUSTRY AND ITS FUTURE IN INDIA

PROVASH CHANDRA KAR

DEPARTMENT OF APPLIED CHEMISTRY, UNIVERSITY COLLEGE OF SCIENCE AND TECHNOLOGY, CALCUTTA

Introduction

THE National Government of India have set their hands on National Planning, elaborate in all ...pects, for the benefit of the Nation, for its dignity ... existence in the scientific world of present day. The development of Alkali Industry will doubtless ... escape their purview. This industry forms the ...ner-stone in the manufacture of various essential ...cles, *viz.*, Soap, Glass, Paper, Textiles, Paints, ...s, Pharmaceutics, Fertilizers (Nitrate) etc.

Let us take the specific example of glass[1] in ...dia. The total annual production of glass in our ...nd, specially after the World War II, runs to a ...siderable quantity. Soda ash should be abun...ly available to the glass manufacturer to move ... the production of this commodity.

Chlorine is an important and profitable by-...duct of caustic alkalies. It finds application in ... purification of potable water, in the preparation ... bleaching powder, dyes (Chlorinated), synthetic ...ber and liquid chlorine etc.

Uses of Different Alkalies

It is needless to dwell, at full length, upon the ... of different alkalies. Their present overall uses ... India are seen from the consumption figures ...d below :

TABLE 1

...mated distribution of Soda Ash consumed in India (1943)[2]

Industry	Quantity consumed (in tons)	Percentage
...ing and cleaning	38,000	47·50
... ...	10,000	12·50
...r	10,000	12·50
...es	9,000	11·25
...onates	5,000	6·25
...um Silicate	3,000	3·75
...nce Factories	3,000	3·75
...llaneous Chemical Industries	2,000	2·50
Total	80,000	100

At present the figure far exceeds 1,00,000 tons ...ear. The consumption and hence the demand of ... commodity will necessarily rise, as new enterprises for manufacturing dyestuff and pharmaceutics etc. are set up on Indian soil.

TABLE 2

Analysis of consumption of Caustic Soda in India (1943)[3]

Industry	Quantity consumed (in tons)	Percentage
Soap and Glycerine	25,000	50
Textiles	14,000	28
Paper	6,000	12
Other Industries (*e.g.*, oil refining, vegetable ghee)	5,000	10
Total	50,000	100

During pre-war period its annual consumption was approximately half of the above figure. It is the potential source of supply of metallic sodium and chlorine gas - essential requisites for the synthetic chemical industries including rubber.[4] During the years of rapid industrialization the figure may range from 120,000 to 150,000 tons per annum.[5]

The weak alkali, sodium bicarbonate, is chiefly used in this country for medicinal purposes and manufacture of fire extinguishers. The requirement may be low at present but the future possibility is high as industrial plannings on leather and aerated water industry are galvanized into action.

Besides, various physical suspensions of these three essential requisites of commerce *e.g.*, neutral soda (sodium bi-carbonate and soda ash in equal molecular proportions), granular ash, causticized ash or super alkalies, modified sodas (Tanner's Soda containing excess of Bi-Carbonate, Textile Soda, Dyer's Soda), according to specific conditions required, will be demanded and consumed.

The consumption figures of Caustic Potash and Potash Carbonate are not available, but it can safely be asserted that they are not demanded so frequently as their sodium compounds. The chief use of the former is in soft and shaving soaps and of the latter in glass. It should be noted that next to the nitrogenous and phosphatic manures potash and potassium compounds are important for plant growth.

The by-product, chlorine, is consumed to the extent of 20,000 to 25,000 tons and it will be doubled as necessity for the manufacture of organic chlorine compounds, *viz.*, D.D.T., gammexane, chlorinated solvents etc. is realized in this country.[6]

Despite so many channels of uses the industry was, in India, until recently, a type of marine chemical industry, importing during the pre-war days alkalies of values well above one crore of rupees each year. Even recent figures (*vide* Table 3) are not lower than that.

TABLE 3

IMPORT OF SODIUM CARBONATE, CAUSTIC SODA AND SODI BI-CARBONATE[7]

Year	Sodium Carbonate Quan (cwt.)	Value (Rs.)	Caustic Soda Quan. (cwt.)	Value (Rs.)	Sodi bi-carb Quan (cwt.)	Value (Rs.)
1936-37	1280670	50,89,473	124013	36,57,443	121257	5,93,089
1937-38	1487032	59,58,039	818485	42,80,55[illegible]	124161	5,60,488
1938-39	1308526	60,87,763	801134	45,45,438	93841	4,84,340
1939-40	1620984	78,10,153	713613	72,30,601	126774	7,10,705
1943-44	1015977	75,84,389	707098	1,10,91,114	68471	7,23,017
1944-45	1577556	1,22,81,552	841676	1,30,39,680	91195	10,16,766
1945-46	1506887	1,16,17,961	758170	1,16,73,714	93228	10,99,664

RAW MATERIALS FOR ALKALI INDUSTRY IN INDIA

The production of alkali presupposes a cheap and abundant supply of brine or any chloride of the alkali metals, limestone, fuel, air and water.

Some natural deposits.—Besides sodium chloride other salts notably sodium carbonate and sulphate accumulate in the soil of many areas of India, especially in dry climate. These efflorescent deposits are variously named as *Sajimati*, Reh and *Khari*. In the United Provinces (Benares, Jaunpore, Muttra, Dehra Dun etc.), the Punjab (Lyallpur, Lalakaku, Montgomery etc.), Sind, Mysore, Bombay and Bihar (Champaran, Saran and Muzaffarpore etc.) vast tracts of land are sterile (locally known as "*Usar*") due to these deposits. These salts are drawn up to the surface by capillary action and there is a perpetual cyclic supply from year after year.

Several lake waters also contain varying amounts of these salts. These are the Lonar Lake of Berar, Lake Sambhar, lakes in Khairpur State and eastern Sind.

The Lonar Lake[9] (approx. 344 acres) is a huge source of alkali. During summer two types of incrustations ("*Bhushi*" and latterly "*Papri*") materialize. The formation of *Bhushi* is more common than that of *Papri*.

Potash is available from Khewra[10] mines (Punjab). The "*Reshta*"[11] (crude salt that forms by the solar and wind evaporation of brine in salt pans of Sambhar lake during summer months and collects

TABLE 4

PERCENTAGE COMPOSITION OF *Bhushi* AND *Papri*[9]

Salt	NaCl	Na_2CO_3	$NaHCO_3$	Insoluble (organic matter, clay, etc.)
Bhushi ..	1·41	22·50	18·90	57·10
Papri ..	20·95	36·13	22·12	21·00

along the margin of pans) may be regarded as a source of potash. Salt manufacturers reject it as waste product.

Salt.—Of salt it may be observed that India is on a par with the advanced countries of the world (*vide* Table 5). The rock salt hills in the Punjab, at Kohat and Mandi[12] are decidedly very pure.

TABLE 5

SOME OF THE PRINCIPAL SALT PRODUCING COUNTRIES IN THE WORLD WITH THEIR PRODUCTION FIGURES FOR 1938 (in Metric Tons)[13]

U. S. A.	Rock salt	1,725,8[illegible]
	Other salt	5,547,[illegible]
France	Rock salt and salt from springs	1,264,2[illegible]
	Other salt	346,0[illegible]
Germany	Rock salt	2,694,[illegible]
	Other salt	585,[illegible]
U. S. S. R. (in Asia and Europe) for 1935*		4,349,[illegible]
China (Manchuria including)		3,000,00[illegible]
India : British	Rock salt	191,[illegible]
	Other salt	1,372,[illegible]
Portugal		29,327

Limestone.—The mineral is available mainly at C. P. (Katni, Satna), Assam (Sylhet), Bihar (Rohtasgarh), Rewa, Eastern States Agency, Rajputana, U. P. and the Panjab. But information is meagre on the specific properties and suitability of individual deposits for various industries.

Fuel.—Mostly in the form of coal abounds in nearly all parts of India, but predominantly in northern and eastern parts.

INDIGENOUS METHOD FOR EXTRACTION OF CARBONATED ALKALIES

Formerly sodium carbonate was prepared from the ashes of seaweeds, and potassium carbonate from ashes of land plants. The chief plants used are *Achyranthes aspera*, Bamboos, *Cassia fistula*, *Vitex negundo*, *Indigofera tinctoria*, etc. This method of obtaining potash is practised even now in some parts of America.

* Data for 1938 are not available.

Modern Methods

Natural soda is considerably recovered in U. K., U. S. A., Egypt, South Africa, China and some other countries. In India during summer the crude natural soda (*chaniho*[14]) is worked up from the lakes (dhands) in Khairpur State and Sind. The amount produced varies from 1000 to 2000 tons per year. *Sajjmati* is recovered from many parts of U. P., the method of extraction being similar to that of saltpetre.[15] The use of *Sajimati* in washing, dying, glass and soap dates back to remote antiquity.[16]

Practically speaking, the alkali industry which had been in a state of infancy on the outbreak of the second global war made great headway during the war.

At present the leading alkali manufacturers are :

The Tata Chemicals, Ltd.[17]—it was founded in 1939 at Mithapur in Baroda State. As the name suggests it is an enterprise of the Tatas. The region which was once barren is one of the most important industrial centres in India so far as basic and other chemicals are concerned. Soda ash, Caustic soda, chlorine and a host of other heavy chemicals are among the products manufactured.

As salt is one of the essential starting materials the Okha Salt Works were acquired. Limestone is available nearby.

Soda ash is prepared by the Solvay's Ammonia soda process and the Mithapur plant is capable of turning out 150 tons of soda ash per day. The recovery of ammonia which is the most important function during the last stage (as ammonia is much costlier than soda) is done very effectively and to make up for the losses of ammonia in the cycle of operations ammonium sulphate is added from time to time.

Besides electrolytic caustic soda, obtained by the electrolysis of brine, 20 tons of soda ash per day are causticized in a plant. The production figure of sodium bicarbonate is 10 tons per day (of 99·9 per cent purity).

The battery of cells at the Tata chemicals consists of diaphragm type cells (for electrolysis of brine), the total capacity being 7½ tons of caustic soda per day. Here only half the salt is transformed to caustic soda.

The solution from the cells contains about 10 per cent alkali and 15 per cent sodium chloride. It is concentrated upto 50 per cent caustic soda, salt being removed. This liquor is then heated by producer gas fire in cast iron vessels and finally liquid anhydrous caustic is directly filled into thin steel drums.

(b) *The Alkali and Chemical Corporation of India Ltd.*—Floated in 1937. The production centres are Khewra (Punjab) and Rishra (Bengal).

The capacity for the production[18] of soda ash by the firm is about 20,000 tons per year. Annually about 1,500 tons of caustic soda are produced by this corporation. Chlorine is also produced.

(c) *The Mettur Chemical and Industrial Corporation Ltd.*—first started in 1936 it is situated in South India (Mettur Dam—Madras) and utilizes electric energy obtained from Mettur hydro-electric scheme. Electrolytically produced caustic (approx. 2300 tons a year[19]), liquid chlorine, and bleaching powder are among the products manufactured.

(d) *The Dhrangadhra Chemical Works*—situated in the Dhrangadhra State (Kathiawar). The main articles of production[20] are soda ash (annual capacity about 18,000 tons) and bicarbonate of soda (about 1350 tons annually).

Some aspects of Indian Alkali Industry

Though at present these industries are not self-sufficient for India's demand, they are encouraging ones as their pre-war production were practically nil, but at present they are substantial.

Besides the above mentioned factories some paper and textile factories produce caustic soda for their own consumption by their auxiliary units. This basic heavy chemical is prepared electrolytically by all of them and by lime-soda process by Messrs. Tata Chemicals Ltd. in addition to the electrolytic process.

The available supply of caustic soda is inadequate to cope with the existing demand and an acute scarcity is being felt by the Indian soap makers. Owing to paucity of regular supply of caustic soda during the war, the supply had to be rationed in 1943 and established firms other than those engaged in war production who used to get nearly their full quota, had 50 per cent of their pre-war consumption and with improvement in import this was raised to 75 per cent in 1944.

Roughly, taking for granted that for every 40 tons of electrolytic caustic soda, 35·5 tons of chlorine are liberated (though strictly this may not be practicable everywhere), India will be self-sufficient, rather over-productive, as the entire amount of caustic soda materializes. But in advanced countries, it may be pointed out, the demand of chlorine is always in excess of caustic. And the demand is not so much in the form of liquid chlorine and bleaching powder as in this country, but for the preparation of inorganic and organic chlorine compounds, chlorinated solvents etc.

The other by-product, hydrogen[21], is in many cases, reported to run to waste. But it should be disposed off principally in two ways :

(a) for synthesis of ammonia as in Haber-Bosch process.

(*b*) for hydrogenation of oils and coal (coal is within ready access to alkali manufacturers).

At present the capacity for production of soda ash is about 250 tons per day and is exclusively prepared by Solvay's process, though the actual production is much less.

The present day production of bicarbonate of soda is small and the Ammonia-soda manufacturers may produce it according to the demand.

According to the processes of manufacture, soda ash is generally sold as light ash or weak soda ash (of low specific gravity and is used for industries other than glass) and dense ash, strong soda ash or granular ash (of higher specific gravity and are used chiefly in glass). As far as sodium carbonate is concerned chemically there is no difference between them. The former is produced by calcination of bicarbonate of soda and latter by recalcination of weak soda ash.

At this stage it will not be irrelevant to compare the recent ammonia soda production in various countries. These figures (as are evident from Table 6 below) show the relative order of growth of the industry throughout the worled.

TABLE 6

RECENT AMMONIA SODA PRODUCTION IN VARIOUS COUNTRIES[22]

Name of the country	*Approximate yearly Production in terms of Soda Ash (metric tons)*
U. S. A.	3,000,000
Natural Soda only	120,000)
Great Britain	1,500,000
(Magadi Natural Soda only	50,000)
Germany	1,250,000
France	710,000
Russia	570,000
Italy	387,000
Japan	250,000
Czechoslovakia	150,000
Poland	100,000
Belgium	88,000
Canada	83,000
China	80,000
Yugoslavia	70,000
Spain	50,000
Austria	45,000
Australia	30,000
India	30,000*
Switzerland	30,000
Rumania	25,000
Norway	18,000
Holland	15,000
Venezuela	2,000

It is reported that caustic potash and potash carb. are being prepared in India, but the quantity is not sufficient to meet the demand though small at present.

* At present the figures are on the increase.

Incidentally it may be pointed out that a new two-stage process[21] for manufacturing potash cost from potassium sulphate, coke, and lime has been in operation for several years in Salzbergwerk (a subsidiary of Kali-Chemie A.-G) in Germany. Advantages claimed are: (*a*) comparatively small apparatus, (*b*) continuous operation due to speedy reaction (*c*) greater output and (*d*) small cost of energy required.

In the first stage, potassium sulphate and milk of lime are heated in autoclaves at above 200°C and the mixture is allowed to react with gas containing 30-32 per cent carbon monoxide, (generated from coke), under high pressure, whereby concentrated solution of potassium formate is formed and calcium sulphate is obtained as by-product. By adjustment of suitable experimental conditions the base exchange between calcium and potassium is minimized and small amounts of soluble calcium salts and potassium sulphate that persist in the lye are removed by precipitation with potash carb. and by evaporation. In the latter stages potassium formate on calcination is oxidized to corresponding oxalate by surplus combustion air and converted to potash carb. of 99·5 per cent purity.

FUTURE PROSPECT

The production of alkalies on a large scale has been spurred on by the huge consumption of soda ash and similar alkalies. Otherwise, a vast amount of money would be sent to foreign markets as evinced previously.

The indigenous method of manufacture of potash may prove profitable to the local inhabitants. The utilization of various species of wormwood[24] in India to prepare potash, has been advocated to the poor inhabitants. Extraction of potash salts from molasses[25] (waste product of sugar industry) also offers a very bright prospect.

The manufacture of reh salt from efflorescent deposits and further treatment of the latter to form soda ash and caustic soda have been elaborately dealt with by Mazumdar.[26] It is expected by experts that 73,21,000 tons of crude salts containing 48,88,000 tons of soda ash could be annually obtained from deposits of U. P. alone. Though the method was chalked out on a peacetime market, it is adaptable to the exigencies of war-affected economic crisis.

Recently the recovery of soda ash and caustic soda from Reh (for use in soap) has been reiterated by researches on soap at the Government Industrial Laboratory of the Punjab.[27]

Extraction of soda and sodium salts from Lonar Lake[28] (starting material being *Bhushi*, as the lake water as starting material will be very expensive

...s been developed. It throws a further interesting ...light on the recovery of alkali from natural ...rces. In brief, the recovery is by a process which ...ploits the wide variations with temperature in the ...lative solubility of sodium chloride and carbonate. ...nal product obtained contains 98 per cent sodium ...rbonate. The inadequate transport facilities of the ...al product for marketing can be overcome by the ...t that local glass producers can utilize this to ...eir utmost convenience.

Katni[29] will be the centre of a small scale Soda A...h Industry (annual capacity 600 tons). From the ...int of view of site selection it is good choice of the ...ovincial Industries Committee of C. P. & Berar.

Causticization of soda ash in places other than ...ories attached to soda ash plant is costly due to ...h cost of soda ash and cannot compete, in this ...untry, with the electrolytic caustic. The Soda Ash ...anufacturers enjoy several advantages for causti...ation: (a) Soda prepared by Ammonia Soda process ...ves as high grade raw material for causticization, ... Carbon dioxide gas required for the production of ...dium carbonate and bicarbonate is obtained by ...rning limestone in the lime kiln, and the excess of ...ne thus obtained is best utilized in causticization, ... No joint product, e.g. Chlorine or Hydrogen as electrolytic industry is there for disposal.

Causticizing of soda ash and settling rate of ...lcium carbonate with reference to various factors ...ave been elaborately studied by Olsen and Direnga.[30]

TABLE 7

PROPOSED DISTRIBUTION OF CAUSTIC PLANTS IN INDIA
(Capacities, tons/day)

(...clusive of auxiliary units and a mercury cell plant)[a]

Province or State	Existing: Electrolytic Process	Existing: Lime Process	Already contemplated Electrolytic Process
Bengal*	5	..	5(a)
Delhi	...	...	5(a)
Kathiawar ...	7·5	17·5	5(b)
Bombay	...	...	5(a)
			2 × 5(c)
Hyderabad ...	...	...	5(b)
Mysore	...	...	5(b)
Travancore ...	...	.	1(b)
Madras	5	...	5(d)

(a) Lease-lend plants for Bengal, Delhi and Ahmedabad.
(b) Plants are under way.
(c) Plants for which licenses have already been granted.
(d) Duplication of existing plants at Mettur.

* The above plant (capacity 11,000 tons of caustic soda) ...o be installed in Bihar as recommended by the panels ...n Heavy Chemical and Electrochemical Industries set up by the Government of India.

Of the two types of cells for the electrolysis of brine *viz.*, (*a*) Mercury cells, (*b*) Diaphragm types, for India the latter types are preferable owing to obvious reason that mercury is not available in India.

It is understood that the same panels have recommended the increase in the production of Soda Ash and Caustic Soda whereby according to a five year plan (1947-1951) by the Government of India the production of Caustic Soda and Soda Ash will be augmented to 133,000 and 270,000 tons respectively per year. Accordingly four new plants for the manufacture of Soda Ash of 50,000 tons capacity in Sind & Bihar and two of 30,000 tons capacity in C. P. and South India have been recommended. Besides there will be Caustic Plants distributed in different parts of India. 30,000 tons of D.D.T. and "Gammexane" are to be produced from the chlorine liberated.

Plentiful supply of raw materials in proximity and transport facilities with cheap thermal or hydro electric energy will determine the site of this important and lucrative industry and the demand will ensure its future.

CONCLUSION

Unavailability of cheap electrical energy, practically speaking, is the real bottle-neck in the expansion of this industry. Full harnessing of water powers in India is being primarily stipulated for.

Nothing comes out spontaneously. The developments that we find today are due to extensive research for years past by experts. In the U. S. S. R. a National Research Institute[31] for soda industry has recently been established at Kharkov. It is the first of its kind in the world and has rendered valuable services for the re-establishment of soda plant in the Donetz Basin. No doubt, in India, such work will be carried out by the prototype 'The National Chemical Laboratory', and it should help the alkali industry in two ways ; (*a*) by advancing methods of extraction from natural deposits, (*b*) by directing modern methods suitable for this sub-continent. For the solution of any industrial problem, research (both fundamental and applied) is the only agent.

Collated information regarding processes and conditions of manufacture in other advanced countries should be available from the Central Statistical Office or a Bureau of Scientific Information should be set up. But State help in financial problem is of much more importance.

Finally, protection against foreign competition should be introduced by the Government in all possible ways (*e.g.*, by avoiding dumping of foreign products, by not allowing any concessional tariffs on foreign imports etc.) in order that the industry may be in the saddle. At the same time consumer's interest must also be safe-guarded.

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NATIONAL HERBARIUM FOR INDIA

I*

I was interested to read Ghosh's note on National Herbarium for India, I have to point out an important omission *viz.*, that the Forest Herbarium at Shillong contains a most representative collection of the flora of Assam and type sheets of at least a dozen species new to science have been housed there. I bear out what Mr Ghosh says regarding a National Herbarium.

[1] Ghosh, A. K., SCIENCE AND CULTURE, 13, 75, 1947.

II†

Mr Ghosh's letter[1] on this subject is welcome and stimulating. In other places[2,3] I have given my personal views on the expansion of the Botanical Survey of India and the scope of authentication of Indian Herbarium materials with the type specimens in different European Herbaria. Mr Ghosh has suggested the return home of some 15,000 Indian type-sheets from all over the world. This step involves so many practical difficulties, that I have doubts whether this would ever be achieved. As I have worked in a number of herbaria like Calcutta, Edinburgh and am at present working as a member of the staff of the Kew Herbarium, I feel, that I am in an advantageous position to comprehend the practical side of the proposal. I should like to draw the attention of readers to two important points.

(i) *Wallichian Herbarium.* It is not a fact as stated by Mr Ghosh that there is no set of Wallich's plants in India. There is a good set at the Calcutta Herbarium. Briefly stated the history of the Wallichian Herbarium is as follows. The great collection of plants made by Wallich was sent to London and distributed to different European herbaria during the years 1828-32, along with the well known Wallich's Catalogue, often referred as "Wall. Cat". Collections of other contemporary botanists were also merged in this main Herbarium as stated in page 60 of the Wall. Cat. These were collections of Russell, Klein, Heyne, Rottler, Buchanan-Hamilton, Roxburgh (a small collection), Finlayson, and Wight. The distribution of set proceeded slowly and Wallich addressed a letter to the Linnean Society, London in October, 1832, requesting the Council to transmit the best set to Calcutta. By the end of that year neither Kew nor Calcutta had received any Wallichian set. It was by good fortune that the residuum of this great herbarium was later entrusted to J. D. Hooker and it was about the years 1850-52, Hooker with his friend Dr T. Thomson was able to make up two "fairly complete sets at least in so far as the plants collected by Wallich himself are concerned". One set was laid in the Herbarium at Kew and "a similar set was taken to Calcutta by Thomson". This took place about the years 1853-55, and thus Wallich's wish was fulfilled and one of his sets is now available in India and could be consulted.

* Note by Mr R. N. De, Chief Forest Officer, Mayurbhanj State, Orissa, dated 3-9-1947.

† Note by Dr D. Chatterjee, The Herbarium, Royal Botanic Gardens, Kew, England, dated 6-10-1947.

The set is rich in types, co-types and lectotypes of Indian plants.

(*ii*) *Other collections.*—Plants have been collected from all parts of India since the time of Linnaeus and even before (*e.g.*, Rheede). The active period could be reckoned to be about 150 years from 1750 to 1900. A selected list of important collectors is given below. The names are followed by numbers which indicate the name of the herbaria where the major collections were originally housed.

Aitchison (2); Anderson (1, 2); Beddome (2, 16); Brandis (2, 16), Clarke (1, 2); Collett (1, 2); Cooke (1, 2, 17); ...ell (1, 2, 17, 18); Duthie (1, 2, 18); Falconer (1, 2, 6); ...ble (1, 2); Gardener (1, 2); Gibson (1, 2, 17, 18); ...ith (1, 2, 7), Hamilton, Buchanan- (2, 3, 4); Helfer (1, 11); Heyne (1, 2, 3, 4); Hohenacker 2, 7); Hooker f. (2, 4, 7); Jaeschke (2); Jameson (2, 4, 5); Jenkins (1, 2); ...on (1, 2); King (1, 2, 4, 9); Koenig (3, 14, 15); Kurz (2, 11, 12); Law (1, 2, 6, 7, 14); Lawson (1, 2, 16); ...enault (8), Lister (1, 2); Lobb (1, 2, 5); Maingay (10), Mann (1, 2); Parish (1, 2); Perottet (7, 11); Prain ..., Rheede (13); Rottler (1, 2, 3, 4, 7); Roxburgh*; ... (1, 2, 6, 7); Russell (2), Smith (1, 2); Stocks (1, 2), ... (2, 6, 8) Talbot (1, 2, 17); Thwaites (5, 7, 8, 11, Trimen (1, 2), Wallich (1, 2, 3, 4, 7, 8, 9, 10, 12); Walker Watt (1, 2, 4), Wight (2, 4, 7), Winterbottom (2, 6, 8); ...row (1, ...)

Calcutta.	7. Geneva	14. British Museum, Lond.
Kew.	8 Paris.	
Linn Soc. Lond	9 Berlin	15. Copenhagen
Edinburgh.	10 Leyden	16. Madras
Dublin.	11 Vienna.	17. Poona.
Leningrad (St. ...rburgh	12 Munich	18. Saharanpur (now shifted to Dehra Dun).
	13 Gottingen	

From a study of the above it will be realized that next to Kew, perhaps the most complete composite collection of Indian Plants is available in Calcutta. Smaller number of duplicates of many of these collectors went to other herbaria which are not named above. These herbaria being those at Zurich, Prague, Kiel, Leipzig, and Turin. The best set of Wallichian collection went to the Linnean Society, London and this set was handed over to Kew in 1913. The next best set and the best collection of Wallich's Nepal plants went to Geneva.

The poverty of type-specimen is more apparent than real as for practical purposes the co-types and lectotypes are available in most cases in India. A co-type being a specimen gathered from the same plant and at the same time as the type, is as good for botanical work as the type. By exchange of duplicates the chances of getting co-types or other authenticated sheets (*e.g. ex numero*) are increased. It is well known that Duthie and Lace regularly sent duplicates to Calcutta and Kew. Many species were described from their collections and this gave advantage to both these herbaria. While at Calcutta, Smith (Sir William Wright-Smith F.R.S.) described many new species about the years 1910-12. The type sheets are all at Calcutta but the co-types are available in Kew and Edinburgh. Even in Kew, as is commonly believed in India, we do not have all the types of all the plants. But we always try to get our sheets authenticated with the type material. A type specimen undoubtedly has great value, being the historic material on which the original description was based. I fully admit this. But for productive work, the type specimen in itself, may convey very little. Such work is only possible with a first class reference library (built on the same lines as Kew), a classified, indexed, and named collection of drawings, carpological and spirit collection, and with fully trained personnel. It is the combined effort of all these together that produces first class work and brings recognition to the institution.

Originally when plants were collected in India no legal ban existed against collection or export of plants. A plant collected for scientific study from the virgin forest of Abor Hills, Chitral, or from an altitude of 17,000 feet in the Himalayas is of very little significance to the man in the plains. It could not be argued as something of cultural necessity for him as the word culture implies close and intimate association of man. In most countries all over the world there is no ban on collection of plants. Where such a ban is imposed a permission to collect plants for scientific study is easily available. Early in this century, Meebold collected several thousands plants from India and Burma. His main collection was lodged in important Herbaria in Germany and duplicates were given to Calcutta and Kew. It is quite possible that most of this collection is now destroyed by World War II including many of the types on which new species were based. Fortunately, in such a case, the duplicates lodged in other herbaria become all important. Numerous other species were described originally from plants obtained from Malay, Sumatra, Java and Indo-China by Blume, Miquel, Loureiro, Vahl, Retzius and others. These plants were later found in India. In such cases recovery of the type sheet is out of question and an authenticated sheet is the only solution for herbarium work.

These special cases show that the importance of type specimen is not absolute but relative for herbarium work, specially when its absence is made up by co-types and other authenticated sheets. What is more important is the first class library and trained personnel. These two matters should have been given emphasis in Mr Ghosh's letter.

Because of the large number of types and authenticated sheets which are housed at the Kew

* A small collection of Roxburgh's sheets went to Kew and Geneva but the majority were difficult to trace. Griffith believed that they were mixed with Wallichian collection but now could not be differentiated. Roxburgh's original coloured drawings (2382) of Indian plants are now in Calcutta. Copies of these drawings were made and a ... number is available at Kew. A third set of 1825 drawings ... to Brussels.

Herbarium, together with the magnificent library, this Institution tends more and more to become of international importance in botanical science. It is of the greatest importance therefore that the majority of type sheets should be preserved in one herbarium and it is also important that the magnificent collection of Kew should be augmented by authenticated sheets of new species wherever possible. Through international co-operation, duplicates and co-types of new species are for the most part received at Kew through exchange and this Institute possesses on that account, perhaps the richest Herbarium in the World.

I hope my friends in India will not mistake my attitude as outlined above; the point which I desire to make in all sincerity is that for critical systematic or taxonomic work the type sheet upon which a species was based is not absolutely necessary *provided* a co-type or other authenticated sheets of the same species are near at hand. The latter is of very real importance and most herbaria of the old and new worlds make a practice of getting their sheets authenticated by a competent systematist, besides obtaining photographs of the type sheets wherever possible. After all science knows no boundaries and for the progress of botanical science we should aim at world wide co-operation and interchange of ideas.

[1] SCIENCE & CULTURE, *13*, 75, 1947
[2] *Nature*, *160*, 387, 1947.
[3] SCIENCE & CULTURE, *12*, 418, 1947

III*

According to Chatterjee, the return home of some 15,000 Indian Type-sheets from all over the world involves so many practical difficulties, that he is in doubts whether this could ever be achieved. Personally speaking, I think, that the difficulties could be easily overcome provided, if our friends overseas, with whom we have maintained a most cordial relations for the last one hundred and fifty years would appreciate the natural and rightful demands of botanists in India that the Indian collections specially the types should be preserved in India.

The following inaccuracies in Chatterjee's letter need comment. The main trouble centres round the 'Wallichian Herbarium', the history of which is now well known.[1, 2, 4, 5, 7] The fact remains that no full set of this herbarium ever came to India. Among Wallich's letters there is a receipt issued by Dr F. Booth, Secretary, Linnean Society, dated September 29, 1832 that he had "received of Dr Wallich five hundred and fifty one bundles and twenty five boxes of dried plants being the whole of the East India Herbarium under his charge." Chatterjee states that there is a 'good set' of Wallich's plants at the Calcutta Herbarium. This is misrepresentation of fact, as the set alluded to is an incomplete set of duplicates now incorporated among the four million sheets of the general herbarium at Sibpur.

Chatterjee's views regarding the 'Type Specimens' cannot be supported for the simple reason that the Type is always to be regarded as a national trust and every country should get back its Types wherever they may exist with the co-operation of botanists all over the World. The suggestion that 'the majority of type sheets should be preserved in one herbarium' (*i.e.*, at Kew) expresses a one-sided view. Chatterjee conveniently forgets that neither an illustration nor a description is a good substitute for a type sheet that are so essential for original monographic work of families, genera and species. Co-types or authenticated sheets of many Indian plants are also non-existent in the Indian Herbaria.

Our readers may be interested in the following facts regarding the importance of the 'Wallichian Herbarium' and herbariums in general. "How far an effort was made by the Linnean Society to carry out Dr Wallich's wishes (to transmit the best obtainable set to India) is unknown; we know that no specimens were sent by them to the Calcutta Garden. It is, however, interesting to find that this request was made and that Wallich, before his return to India in 1832, had already realised the consequences of the distribution 'to various bodies in this country and in Europe' of the 'plants collected by celebrated naturalists in the Company's service during a series of years, in India' without arranging that 'the best set obtainable' should be placed in the 'Garden at Calcutta' at whose expense and on whose behalf the bulk of these collections had been brought together. It may be that when Wallich, in 1828, obtained the approval of the Court for the list of the institutions to which he proposed that sets of specimens should be given he did not contemplate the necessity of returning to India and that to this circumstance may be due the omission of the Calcutta Garden from the list of recipients of its own specimens. We know that when, in 1847, Wallich returned to Europe and had himself an opportunity of doing what was still possible to repair the injustice which had been committed he did not take that opportunity. It was left to Hooker and Thomson to do what Wallich had left undone." (*Kew Bulletin*, 1913, p. 258).[7]

The residuum of the Indian Herbarium, after the distribution of this great collection that took

* Note by Mr A. K. Ghosh, The Herbarium, Calcutta University, 35, Ballygunj Circular Road, Calcutta 19, dated 12-12-1947.

...ce between 1828 and 1832 by Wallich* on behalf of the Honourable East India Company was later entrusted to Kew. Unfortunately like the Calcutta Herbarium, at whose cost and for whose benefit the collections were brought together, no set of Indian plants till then reached Kew.[7] (K.B. 1912, p.5)

Hooker and Thomson[1] stated "As all the duplicates were made up into sets, ticketed, and distributed at home and abroad, this herbarium has taken the place of a standard work of reference, and it is impossible to overestimate its value, or the importance of the constant access which we have enjoyed to its contents." Further, Thomson[2] stated "The Wallichian Herbarium has, therefore, become one of the foundations of Indian Botany, and it is a source of regret to me that a set of its specimens does not form a part of our collection here (Sibpur)". Thomson has further cited a list of the collections incorporated in the Calcutta Herbarium in which Wallichian Herbarium is conspicuous by its absence. Earlier in 1843, Griffith also strongly protested against the denudation of Wallichian Herbarium from India and urged its transfer to India for the benefit of Indian botanists. Between 1815 and 1828, a large and valuable series of botanical drawings prepared under Dr Wallich's superintendence were also taken to England and deposited at the India House. As no copies were made, we do not, as in the case of the Roxburghian drawings, possess a corresponding set.

Hooker[3] in 1865 stated "In the year 1857, at my suggestion the court of directors of the hon. E.I.C., transferred to my charge the various botanical collections contained in the India House, with the view to their being examined and reported upon and in the following year, the Secretary of State for India, sanctioned a proposal, on my part, that they should be named, catalogued and distributed". It should be noted that no Wallichian sheet was included in this lot but sheets of Griffith, Falconer, Helfer, and Wight began to arrive in Calcutta on and from 1870 onwards as could be gathered from the Annual Reports of the Sibpur garden for those years.

* Wallich was appointed a member of a committee of ... including Robert Brown, Francis Booth, George Bentham and himself, whose duty it was to superintend the arrangement of the herbarium and the provision of cabinets in East India House. The Court of Directors of the East India Company, voted a sum of £200 for the purchase of paper only upon which to mount the specimens.

The original set of 'Wallichian Herbarium', preserved in its original mahogany cabinets was transferred to the Kew Herbarium in 1913, owing to lack of space in the Linnean Society's apartments and the Kew Herbarium is holding this set on behalf of the Linnean Society.

Regarding herbariums in general, I would draw the attention of Dr Chatterjee and other botanists in India, as well as the Government of India, that the Committee of the Botanical Society of America on the United States National Herbarium, unanimously adopted in December, 1946, that the various botanical collections of the Government may be brought together as the law provides. The committee further recommended to the Congress of the United States to provide more space, adequate budget, and suitable staff to insure proper scientific development and utilization of the national collections in botany. This recommendation is based on a wiser precedent set in Switzerland, where vast and valuable botanical collections (Boissier's and De candolle's) at Geneva have been combined under a single effective administration. (As such, two, if not three sets of Wallich's set went to Geneva). It would avoid the irremediable* mistake that England made, for instance, by setting up two competing and duplicating herbaria in the British Museum and the Royal Botanic Gardens, Kew for fifty years at public expense. This mistake is also repeated by setting up a number of regional herbaria in India, as a result, types are scattered over a number of places in India itself, and not centralized at Sibpur, which is really the nucleus for a 'National Herbarium for India'.

My thanks are due to Dr K. Biswas, Superintendent, Royal Botanic Garden, Sibpur, for giving me the necessary facilities to consult the unpublished official documents required in writing this note.

* It is said that the barrier to fusion of the two rival departments is that they use different sizes of paper for mounting their specimens. If this could be done, India could perhaps easily get back a set.

[1] Hooker, J. D. & Thomson, T., *Flora Indica*, pp. 58-74, 1855.
[2] Thomson, T., *Jour. Roy. As. Soc. Beng.*, *25*, 405-418, 1856.
[3] Hooker, J. D., Catalogue of the plants distributed at the Royal Gardens, Kew, 1865.
[4] King, G., A Sketch of the History of Indian Botany, 69th meeting of the British Association, pp. 904-919, 1899.
[5] Hill, A. W., The Indian collections at Kew and the relations between Kew and Sibpur., *Proc. 25th Ind. Sc. Cong.*, pp. 133, 1938.
[6] Bartlett, H. H. *et al*, *Am. Jour. Bot.*, *34*, p. 296, 1947.
[7] *Kew Bulletin*, p. 5, 1912; p. 258, 1913.

Notes and News

INDIAN SCIENCE CONGRESS

THE 35th Annual Meeting of the Indian Science Congress Association was opened on Friday, January 2, 1948 by H. E. Sri Jairamdas Daulatram, Governor of Bihar at the Patna University in the presence of a large gathering of delegates, members and visitors.

Lt Col Sir Chandreshavar P. N Singh, Vice-Chancellor, University of Patna, and Chairman, Reception Committee, welcomed the members, delegates, guests and visitors to the ancient city of Pataliputra. He said, "In this twentieth century, it is to men of science and to men imbued with the scientific spirit that Man turns for guidance in the building up of a brave new world"

Tracing out, Bihar's rich and a hoary past he said, a glorious past should be an incentive to action and to progress towards the realization of a future. Past is beyond recall but the future is in our hands. Our world to-day brushes aside reason and intelligence. The majority of population of the earth has been caught in the eddy of destruction. There are hundreds of problems that threaten the human existence and the atom bombs cannot solve them. Human civilization can no longer be betrayed by science.

Sir Chandreshvar admitted that in India to-day after centuries of political subjugation and consequent intellectual stagnation, the spirit and service of science were sorely needed. Indian intellect was more assimilative. Our education had to be so reoriented that scientific spirit of intellectual discipline filtered to masses and pervaded all the strata of society.

Sir Chandreshvar said that time had come for an international body of scientists to control the release and distribution of scientific knowledge, specially such knowledge as may be used to perfect technological progress.

Inaugurating the meeting H. E. Sri Jairamdas Daulatram said, "Science is not and has never been an end in itself. Each step, taken by man up the endless spiral of knowledge, has been instinctively to fulfil some urgent need to satisfy some compelling urge." Man has sought knowledge stirred up by purpose and impelled by an urge to move forward which is embedded in the very stuff of which this universe is made, whether inanimate or animate. The animal in man, yet his dominant feature, demanded at first the satisfaction of what the body required. Is not mankind feeling the need of progress in the moral sphere?

Tracing out the history from the stone age to the atomic age, Sri Daulatram said, it was continuous story of man's efforts to gain and use knowledge. There was continuous movement, continuous adjustment, continuous aspiration, continuous achievement, which happened to be the law of action, inherent in Nature. This process was in physical sphere, in mental sphere and he said man would see it also in moral sphere.

Pleading for all-out co-operation of the scientists for the national regeneration and reconstruction, Sri Daulatram said they could dare not mark time when one crisis after another called for big rapid strides on the path of reconstruction. He said the law of evolution did not end with the body and mind. Everything changed and so changed the moral side of man. India must establish supremacy of moral law and the use of moral means for all ends.

Sri Daulatram continued saying that India had traditions of some of the more mysterious aspects of the complex human personality. By some power, not yet recognized by modern science ancient seers of India calculated with precision the movement of stars and there were many others who did such marvels in the domain of science. Science of *Yoga* had yet to be systematized in both physical and moral aspects. Great thinkers in ancient India made instrumentless researches into the things of spirit and discovered the solution of this eternal problem of human happiness.

Sir C. V. Raman, a past General President of the Association, presided at the meetings, owing to the absence of the President-elect Sir R. N. Chopra. Sir Raman read out Sir Ram Nath's Presidential Address entitled "Rationalisation of Medicine in India" (see SCIENCE AND CULTURE, January, 1948 Supplement). Sir Chandrasekhar then spoke on the human sense of taste and smell. He showed how both these senses were connected with fundamental processes of human life.

NATIONAL INSTITUTE OF SCIENCES OF INDIA

IN his presidential address at the Thirteenth Annual General Meeting of the Institute held in Science College, Patna, on the 1st January, 1948, Sir Shanti Swarup Bhatnagar observed, "In a free India, science is no longer to be the tool of a foreign imperialism, and its two great tasks now are to develop Indian scientific talent to its utmost capacity so that

it can make a worthy contribution to humanity's pool of scientific thought and knowledge, and to develop India's resources so that the lot of the common man in this country may be improved."

Sir Shanti added: The tasks of scientific education in this country henceforward have to be vastly different from those assigned to it hitherto. The scientific surveys of India's resources in the past were primarily inspired by the imperialist purpose of the exploitation of these resources by her alien rulers.

To raise the economic standards of the common man, it is necessary that the speed of industrialization be a good deal accelerated. Indian industrialization demands adequate exploitation of the country's vast power resources. India will have to develop her science and industry for defence purposes, if she is to maintain her freedom and to pursue an independent foreign policy.

Referring to the question of language, Sir Shanti said: "The teaching of science will henceforward have to be done through Indian languages and our universities and learned bodies, scientists and teachers must now be called upon to take effective steps to make this possible without any impairment of efficiency.

"For the immediate future, I think we have to be content with the English terminology."

The following were elected as officers and members of the Council of the Institute for the year 1948: *President* Sir S. S. Bhatnagar, (Delhi); *Vice-Presidents* -Prof. S. N. Bose, (Calcutta), Major-General Sir S. S. Sokhey, (Bombay); *Treasurer*- Mr M. S. Randhawa (Delhi); *Foreign Secretary* -Dr J. N. Mukherjee (Delhi); *Secretaries* - Dr D. S. Kothari (Delhi) and Dr H. S. Pruthi (Delhi); *Editor of Publications* -Dr S. L. Hora (Benares); *Members of Council* -Prof. S. P. Agharkar (Poona); Dr K. N. Bagchi (Calcutta); Prof. K. N. Bahl (Lucknow); Prof. A. C. Banerjee (Allahabad); Mr S. Basu (Poona); Prof. H. J. Bhabha (Bombay); Prof. S. R. Bose (Calcutta); Dr B. B. Dey (Madras); Dr Verrier Elwin (Benares); Prof. B. C. Guha (Calcutta); Dr S. Krishna (Dehra Dun); Prof. S. K. Mitra (Calcutta); Dr B. Mukerji (Calcutta); Dr C. G. Pandit (Madras); Dr P. Parija (Cuttack); Dr M. Prasad (Bombay); and Dr W. D. West (Calcutta).

INDIAN CHEMICAL SOCIETY

At the 24th Annual General Meeting of the Society, held on January 1 last at the Science College, Patna, Prof. P. Rây in his Presidential Address referred to India's past history. He observed that India's contribution in arts, literature, philosophy and science was in no way inferior to that of any of her contemporary nations, if not actually better. It is now an acknowledged fact that India's past achievements in arts, literature and philosophy were of the highest order, and have drawn unstinted admiration and reverence from the best of our modern thinkers. In practical sciences too, her contributions were far ahead of the time. The famous wrought iron pillar at Delhi near *Kutab*, believed to have been constructed in the 4th century A.D., which has wonderfully withstood the onslaught of rain and air for over fifteen centuries, numerous iron beams and clamps of very large dimension in the temple at Bhubaneswar and at Konarak (600-900 A.D.), huge iron girders in the temple of Puri (1174 A.D.), the solid copper bolt in the Rampura Asoka pillar near Nepal believed to be a product of the 3rd century B.C., the huge copper statue of Buddha weighing about 1 ton found at Sultangunge in Bhagalpur and believed to be a product of the 5th century A.D., are but a few of the numerous evidences of the remarkable skill displayed by the early Indians in large scale metallurgical and metal work, in spite of poor appliances at their disposal at the time. In the field of preparative chemistry reference may be made to the preparation of *mridu kshara* or mild alkali (carbonate) and *tikshna kshara* or caustic alkali so meticulously described in the *Ayurvedic* treatise *Susruta* as early as the 5th century B.C. These methods are characterized by such a high degree of perfection that they can be bodily transferred to any modern text book of chemistry. While recalling these glorious achievements of our forefathers in distant ages we cannot overlook the fact that as soon as India lost her freedom, she practically sank into a dark age with absolutely no record worthy of note ragrding her activities in experimental sciences, and as the late Sir P. C. Ray very painfully but appropriately puts "her name was all but expunged from the map of the scientific world". From this intellectual torpor there has, however, been an awakening from the beginning of the present century, and while India regains her freedom to-day, it becomes a bounden duty for every one of us to put forth his best to revive her ancient glory so that we may claim for her once again a rightful position in the scientific world, and prove ourselves worthy of our great cultural heritage.

Referring to the subject of changing the medium of instruction in our Universities from English into the language of our own country, Prof. Rây said that this is quite natural and is as it should be from the nationalistic point of view. But fortunately or unfortunately in India many things, which are quite natural and obvious in other countries, assume a somewhat different and complicated aspect from the viewpoint of her national growth and national welfare, because of her unusual geographical position,

her colourful past history, variety of her provincial language, and diversity of her population and their habits of life. The question is what should be the medium of instruction in different provinces of India. If each province adheres to its own provincial language as it naturally does even up to a certain standard now, a considerable difficulty would be experienced in inter-provincial cultural intercourse and administrative activities.* If a national *lingua franca* for the entire Indian dominion is adopted, as is suggested, which may be Hindi or Hindusthani, then in addition to each provincial language, the national language should also be made compulsory for every stage of our education. Then, if we are to keep ourselves in touch with the cultural flow of Europe and America we shall have to retain English as a compulsory second language in all our Colleges and Universities, if we do not want to isolate and cripple ourselves both intellectually and culturally. All these difficulties are sure to multiply manifold in the case of scientific subjects with their characteristic terminologies and symbols. Imagine the way in which we shall have to carry out our discussion in All-India scientific gatherings like the Indian Science Congress Sessions, the National Institute of Sciences of India, and the various All-India Scientific Societies like ours. What will be the character of our organ, the Journal of the Indian Chemical Society, and, for the matter of that, of all other similar scientific Journals now published in India? If workers of different provinces send in their contributions in their own provincial languages and scripts, it will create not only serious difficulties in their printing and publication, but will defeat the very purpose of such Journals, which, as has been stated above, aims at a free and unfettered exchange of information and ideas for the progress of science. It may, however, be argued that the publications will be made only in the *lingua franca* of India and in a script of its own with common terminologies. Then again, it has to be considered whether under such altered conditions, we shall be able to maintain our exchange relation with the learned societies of Europe and America undisturbed, and whether our publications will receive due notice in the abstracts of foreign countries, which is so essential to our activities and progress. I am afraid, it will be too much to expect such recognition from abroad unless our contributions attain such a high standard as to compel the foreign scientists to look for light and guidance from us. We shall thus be cut off and isolated from the scientific progress of the world, which we certainly do not desire.

* Migration of students from one provincial university to another, selection of teachers from one province for another, recruitment of officers and specialists for central public services will be associated with enormous difficulties, if not altogether inoperative and unpracticable.

The problem, therefore cannot be solved province-wise. It is an All-India problem and should be thoroughly discussed in All-India organizations. First of all the various All India Scientific Societies should discuss this problem in their individual organizations and communicate their considered opinions to the Indian Science Congress Association and the National Institute of Sciences of India for a final recommendation on the subject to the Government of India.

A NEW BATTERY

A very interesting development during the last war has been the design of a novel battery which is capable of giving a huge current discharge at about 1.5 volt for a short period of a few minutes, after which the voltage falls down to 0.3 volts. A typical cell measuring 1¾" diameter × 2⅝" long delivered 100 amperes at a peak voltage of 1.4 volt for 1.5 minutes. The positive electrode of this cell is a silver foil of one-thousandth inch thickness, both sides of which are coated with electorolytically formed silver chloride. The negative electrode is a commercially pure magnesium foil of similar width. Wire electrodes are welded on to the two electrodes and the method of assembly is similar to the one used for paper dielectric cylindrical radio condensers. The only difference is that dry absorbent paper is used between the two electrodes. These cells are manufactured at 80°F and an atmosphere of relative humidity of 22.5% (corresponding to 38°F dew point).

Two or more cells are easily assembled by wrapping the first with a layer of insulating plastic film or insulated paper, upon which the 2nd cell is wound. When high voltages are required at low discharge rates, flat form of the cell is preferable. The area of the foils is then from 0.59 to 2.625 sq inches. Silver chloride is then formed only on one side and absorbent paper is put in between the electrodes, and an insulation layer is put in between cells when a pile is assembled. The pile is then packed in a sealed can in which a small amount of silica gel is used as a desiccant for storage. Such a battery is absolutely inert after assembly. For use the can is punctured and soaked in water.

Burgess Batt Co. of America is already making 21 different types of these cells. (*See* Electrochemical Society of America, reprint 90-93).

G. R. T.

ALUMINIUM IN FRUIT PRESERVATION

Aluminium foil, which is being widely used as an insulating medium, is now entering the field of fruit preservation. Fruits wrapped in this light metal foil suffer a vastly smaller weight loss as com-

...ed with the unwrapped ones, the insulation ...ectively retards ripening, while this inert non-...sorbent wrapping prevents contamination of the ...k in the case of one of the fruits getting acciden-...ly damaged. In practice, this last effect re-...sents probably the greatest advantage of alu-...minium foil, because, not only is the fruit guarded ...ainst infection by direct contamination, but is ...also sealed against floating spores by a sterile, im-...pervious barrier, the nature of which is such as not to affect the fruit, or when correctly used as a ...wrapper to prevent natural "breathing".

France, with its extensive and world-renowned ...production of apples and pears, appears to be the first nation to have seriously taken up the question of the use of aluminium foil for wrappers. The pre-...servation and transport of fruit are highly important ...scientific and engineering problems, and it is interest-...ing to note the results obtained in France by the simple means of wrapping apples and pears in aluminium foil. The percentage of produce which cannot be consumed because it has become rotten, stained or unappetizing in appearance during transit is often very large. Such accidents occur due to an accelerated ripening of the products. This is the reason why fruits pro-...posed to be sent over long distances are plucked whilst unripe. Although it may obviate or lessen the dangers mentioned above, it is an established fact that fruits plucked unripe and immature never develop the same flavour as those which are allowed to ripe on the tree. For wrapping citrus fruits, oranges and tangerines in particular, tissue paper is universally employed. The search for an attractive means of preservation was the reason why tangerine ...owers wrapped their products in tin foil when ...nding them to market in metropolitan France, but excellent results obtained by the use of aluminium foil in preserving countless fruit products have led to further research with this material as an aid to con-...serve fruits during storage. Pears and apples from the Angers district were selected for the first experiments, which were tested with aluminium foils ... a variety of types, such as plain and lacquered, embossed, and plain foil lined with tissue paper ...ated with paraffin wax. Tests were carried out on ...adian "Le Mans", and "Clochard-Reinette" ...ples, and the "Charles Earnest", "President ...nard" and "Beurré d'Aremberg" Pears. During ... tests, the temperature varied from 3°C. to ... and humidity from 80 to 95. In the particular ... of "Canadian Reinettes", experimental figures ... a very clear and precise idea of the efficiency of ...minium foil wrapper. Thus the commercial value ...his fruit, on leaving the grower, was 65 francs ... Kg. for apples wrapped in this foil as against ... fr./kg. for the unwrapped variety. This means ...in of 20 fr./kg. against an expenditure on aluminium of 1·80 francs corresponding to a total surface of 0·375 sq. m. and allowing six apples to the kg. Each apple was wrapped in a foil 0·012 m.m. thick and 25 c.m. by 25 c.m. square, costing 150 fr./kg. in France. Now as the loss in weight in covering the fruit is only 1·3% as against 11·2% for the uncovered variety, the net cash gain is 6·5 fr./kg. of apples. In fact this saving alone more than com-pensates for the cost of the aluminium foil and labour, and actually gives the producer an additional net profit of some 40% over and above his original selling price. The same indications with slight varia-tions are also given from tests on other varieties of fruits. In fact for "Reinette Clochard" apples which are difficult to preserve, a perfectly fresh and crisp condition can be maintained for a period as long as six months by wrapping them in this material.

Aluminium foil opens out a new and a very profitable field of development in the fruit trade. By constant research and experimentation, this material by its intrinsic properties may well revolu-tionize the problems of transport of food products, ... products on which the whole civilized world to-day looks upon with anxiety. (See *Revue de l'Aluminium*, 23, 161, 1946).

S. K. G.

FILM ON ATOMIC PHYSICS

MESSRS G. B. Instructional Limited—the branch of the J. Arthur Rank Organization Limited have recently produced a five-reel film on the history and development of atomic physics, from the conception of the original idea of the atom to the nuclear fission.

The first reel includes the atomic theory of Dalton, Faraday's experiments in electrolysis, etc. The electrical discharge through rarefied gases and the discovery of the electron are dealt with in the second reel. The third reel deals with the researches of Becquerel, the Curies and Lord Rutherford which is continued in the fourth reel with the works of Sir James Chadwick, and of Cockcroft and Walton in splitting the lithium atom in 1932. The fifth reel covers the more recent events, leading to Hiroshima and Bikini. Scenes from the lives of Lord Rutherford and Sir J. J. Thomson are nicely introduced in the film. Professor Einstein, Dr J. D. Cockcroft and Professor O. Frisch also figure in the film.

Such educational films are not produced in our country but its utility is out of controversy. The attention of the university authorities in India is drawn to this fact, so that arrangements can be made to procure a copy of the film for Indian students.

OBITUARY : SRISH KUMAR SEN

By the death of late Srish Kumar Sen on October 9, 1947, India has lost an unassuming and silent scholar in Systematic Botany. Born on the 1st Magh, 1285 B.S. at Sylhet, Srish Babu read up to the B. A. classes of the Calcutta University and later passed the Agriculture and Survey courses, at the Civil Engineering College, Sibpur in 1899. He was appointed a Sub-deputy Collector and soon after was charged with sedition by the Government in connection with the famous case of Sri Arobindo Ghosh. The Government stopped his promotion and transferred him to Assam. During his stay at Assam he worked in the Citrus Experiment Station in the Khasia Hills and as a settlement officer at Sankarpur. He was a very able and conscientious officer and as a reward for his good services and ability the Government removed the ban on him in 1919 and promoted him as an Extra Assistant Commissioner, Assam. In 1928 he retired from the Government service and settled at Dacca.

Since his boyhood Srish Babu showed special interest in Geology, Botany and Entomology and learnt these subjects thoroughly. He began his career as a Systematic Botanist and explored especially the floras of East Bengal and Assam. He discovered many new plants, not reported before from these places.

In 1939 Prof. P. Maheshwari came to the Dacca University, and he was so much impressed by his deep knowledge and versatility that he requested him to organize the University Botanical Gardens and the Herbarium. Srish Babu at first worked there in an honorary capacity as the Curator of the Herbarium and the Botanical Gardens, Dacca University and from 1944 he officially worked there in the same capacity on a monthly honorarium. The gardens and the herbarium, due to his untiring energy, now contain many rare and interesting plant specimens.

In 1940, he along with Prof. S. N. Bose and others, established the bi-monthly scientific magazine in Bengali (*Bijnan-Parichaya*) by contributing funds for the journal and since then till his death he was the life and soul of the same with a view to educate and benefit the student community with scientific knowledge and thoughts.

He published a number of scientific papers *e.g.*, in the Indian Journal of Pharmacy, Indian Forester, *Bijnan-Parichaya* etc.

May his soul rest in peace.

THE INDIAN DAIRY SCIENCE ASSOCIATION

An Association called "Indian Dairy Science Association" was formed recently at Bangalore and a meeting of the Provisional Executive Committee was held at New Delhi on December 16, last with Sardar Bahadur Sir Datar Singh, Vice-Chairman, Indian Council of Agricultural Research, in the chair. The membership of the Association is open to all persons engaged in teaching, research and advisory work in dairying and to persons holding technical positions in the field of dairying.

The work of enrolling Foundation Members is proceeding briskly and over fifty members have already been enrolled. The object of the association is the advancement of dairy science in all aspects by the dissemination and application of knowledge, providing opportunities for the exchange of knowledge and ideas through discussion and other means, collaboration with other institutions engaged in activities relating to advancement of dairy science, encouragement of scientific enquiry into problems arising in the dairy industry and to publish a journal devoted to dairy science in all its branches as the need for such a journal has been universally felt. For the present the headquarters of the Association is located at the Indian Dairy Research Institute, Bangalore and all communications to be addressed to the Joint Secretary of the Association.

INDIAN SOCIETY OF AGRICULTURAL STATISTICS

The Society was formed in January, 1947 with the Hon'ble Dr Rajendra Prasad, Minister for Food and Agriculture, as its first President. Its objects are to promote the study and research in statistics and its application to agriculture, animal husbandry, agricultural economics, and allied problems. Its membership is open to all persons and institutions interested in the aims of the Society. The Society has on its rolls a membership of over 100. Sardar Bahadur Sir Datar Singh is the *Executive President* of the Society. Other office bearers are Mr M. S. Randhawa, *Vice-President*, and Dr P. V. Sukhatme, *Secretary*. It is proposed to publish a Journal from January, 1948. A special feature of the Journal would be a Hindi supplement giving short summaries of the articles published.

The first annual meeting of the Society was held at New Delhi from December, 11-13, 1947. Presiding at the meeting, the Hon'ble Dr Rajendra Prasad, President of the Society, referred to the poor quality of the published agricultural statistics and stressed the urgent need of improving it both as regards completion and accuracy, as without reliable statistics, no planning of any kind was possible. Although food was the greatest problem facing the country, no policy for food could be formulated for want of reliable data. Emphasizing the need for building up an adequate statistical organization, he urged statisticians to develop scientific methods like those of random sampling and

ар photography for reducing the cost and time in collecting data.

A symposium on 'Statistical Organization for India with special reference to agriculture' was held on December 12 under the chairmanship of the Hon'ble Mr R. K. Shanmukham Chetty, Minister for Finance. Opening the symposium, he said that the building up of a statistical organization must really be given top priority, for, the government cannot plan in a rational manner its food policy without reliable statistics. He said that the Government was just considering proposals for strengthening the central statistical organization and was examining as to how far individual departments should be engaged in the collection of statistics and to what extent the central organization should control the collection in individual departments and in what manner it should co-ordinate it, and added that the Society's guidance on these matters would be most valuable. Dr V. G. Panse, of Institute of Plant Industry, Indore, and Mr W. R. Natu, Economics and Statistics Adviser, Minister of Agriculture, Government of India, New Delhi emphasized the need for decentralization not only in regard to the collection of statistics but also in the training of statistical personnel and research in statistical methods, as, in their view, a close contact with the field to which statistics is applied is absolutely essential for the growth of an efficient statistical service. Others participating in the symposium were Prof. K. B Madhava, Mr K. Keshen (Lucknow), Mr R. S. Koshal and Dr N. S. R. Sastry (Bombay) and Dr P. V. Sukhatme (New Delhi).

A second symposium on the contribution of statistical science to the development of Indian Agriculture was held on December, 13 under the chairmanship of Prof. J. N. Warner of the Allahabad Agricultural Institute. The varied applications of statistics in different branches of agriculture including plant breeding, design of experiments, animal husbandry, fisheries, etc. and the role of statistical science in agricultural economics were discussed.

ELLIOTT PRIZE FOR SCIENTIFIC RESEARCH FOR 1948

The Elliott prize for Scientific Research for 1948 and 1949 will be awarded to the authors of the best original essays giving the results of original research or investigation made by the candidate in Mathematics and published during the years 1944-47 and in Chemistry published during the years 1945-48, respectively. Preference will be given to researches leading to discoveries likely to develop the industrial resources of Bengal, Bihar or Orissa.

The prize is open for competition by natives or any Anglo-Indian or domiciled European, of, or residing in, Bengal, Bihar or Orissa respectively.

The essays of competitors must be sent in so as to reach the President of the Royal Asiatic Society of Bengal, 1, Park Street, Calcutta by the end of June, 1948. The prize will be awarded to the best competitor and publicly conferred at the Annual General Meeting of the Society in February, 1949.

The value of the prize will not be less than Rs. 210.

LADY TATA MEMORIAL TRUST

Scientific Research Scholarships, 1948-1949

The Trustees of the Lady Tata Memorial Trust are offering six scholarships of Rs. 250/- each per month for the year 1948-49 commencing from 1st July, 1948. Applicants must be of Indian nationality and Graduates in Medicine or Science of a recognized University. The scholarships are tenable in India only and the holders must undertake to work whole-time under the direction of the head of a recognized research Institute or Laboratory. The subject of scientific investigation must have a bearing either directly or indirectly on the alleviation of human suffering from disease. Applications should reach by March 15, 1948. The applications must conform to the instructions drawn up by the Trustees. Candidates can obtain these instructions and other information they desire from the Secretary of the Trust, Bombay House, Bruce Street, Fort, Bombay 1.

NEW FELLOWS OF THE NATIONAL INSTITUTE OF SCIENCES OF INDIA

At the Annual General Meeting held on January 1 last, the following were elected as Ordinary Fellows of the Institute: Dr B. S. Bhimachar, Fisheries Officer, Government of Mysore, Bangalore ; Sri Pratap Chandra Bose, Chief Engineer, Corporation of Calcutta ; Dr Satya Charan Chatterjee, Head of the Department of Geography, Patna College ; Mr Jehangir Fardunji Dastur, Head of the Division of Mycology, Indian Agricultural Research Institute, New Delhi ; Dr Arun Kumar Dutta, Reader in Physics, Dacca University ; Dr Rukmini Kishore Dutta Roy, Chemist, Geological Survey of India, Calcutta ; Dr Robert E. Heiling, Chief Physician, Jaipur ; Dr Kolar Ramkrishnaiyer Krishnaswami, Director of Industries, Bihar, Patna ; Mr Robert Anderson MacGregor, Formerly Chief Metallurgist to the Government of India, Calcutta ; Mr Ganesh Chandra Mitter, Chief Assayer, His Majesty's Mint, Bombay ; Dr Mahadeo Atmaram Moghe, Head of the

Department of Zoology, College of Science, Nagpur ; Dr S. P. Raju, Director, Engineering Research Department, H. E. H. The Nizam's Government, Hyderabad (Deccan) ; Dr Srinivasa Ramanujam, Director, Central Potato Research Institute, New Delhi ; Dr Subharao Ramchandra Rao, Professor of Physics, Central College, Bangalore ; and Dr Jyotis Chandra Ray, Director, Indian Institute for Medical Research, Calcutta.

ANNOUNCEMENTS

SIR K. S. KRISHNAN, Kt, D.Sc, F.R.S., Director, National Physical Laboratory, New Delhi, has been elected General President of the Indian Science Congress Association for 1948-49 and the following have been elected as Sectional Presidents: *Mathematics*—Prof. S. Chowla, (Delhi) ; *Statistics*—Dr U. S. Nair, (Trivandrum) ; *Physics*—Dr R. S Krishnan, (Bangalore) ; *Chemistry*—Prof P. B. Ganguly (Patna) ; *Geology and Geography*—Dr C. Mahadevan, (Waltair) ; *Botany*—Mr M S. Randhawa, (Delhi) ; *Zoology and Entomology*—Dr M. L. Roonwal, (Benares) ; *Anthropology and Archaeology*—Sri N. K. Bose, (Calcutta) ; *Medical and Veterinary Sciences*—Dr M. B Soparkar, (Bombay) ; *Agricultural Sciences*—Dr R. S. Vasudeva, (New Delhi) ; *Physiology*—Dr B. B. Sarkar, (Calcutta) ; *Psychology*—Mr T. K. N. Menon, (Baroda) ; *Engineering and Metallurgy*—Prof. M. Sen Gupta, (Benares).

MR PERCY EVANS (of the Burmah Oil Co.) has been awarded the Murchison Medal of the Geological Society of London, in recognition of his researches on oil fields of Burma and Assam, his work in the sedimentary petrology of Indian Tertiaries and geological interpretation of gravity surveys of large parts of India.

ERRATA

On page 210 of the November, 1947, issue in the table "Rare Earths contained as activators in the specimens of Indian fluorites", column 5 *read* 'Eu was present in all the specimens of fluorites and the presence of Pr could not, however, be ascertained definitely due to the strong activating ability of Sm, Dy, Eu and Er'.

On page 253 of the December, 1947, issue, column 2, line 22, *read* "y" for "Y" and line 1? *read* '(Y) (Log)$^{1}_{2}$' *for* '(Y) (Log Y)'.

BOOK REVIEWS

The Electrician By V. L. N. Row. Published by the Industry Publishers Ltd, Calcutta, 1947. Pp. 278. Price 6/-

The book is written with the object of helping those who are interested in the applications of electricity but who owing to the lack of detailed mathematical knowledge are unable to appreciate the underlying principles. The book gives practical hints as how to apply electricity in everyday life. The Electricians who have no advanced knowledge in electricity and magnetism will find it very useful for their job.

The book contains twenty chapters dealing with all possible practical aspect of electricity and magnetism including cells, dynamos and motors, principles of alternating current, transformer and converting plant, electricity in an automobile, measuring instruments etc. The definitions of the terms and other quantities are simple and lucid. The two important features of this book are the inclusion of a chapter on the common workshop tools used by the electrician and also the addition of a number of useful tables and a *precis* of the more important provisons of the Indian University Rules at the end of the book which will be of great help in making preliminary estimates for electrical installations and other jobs which the electricians may be called upon sometime to do.

Simple worked out examples at the end of each chapter would have been much appreciated as it enables one to understand and apply the things more easily.

The printing and the get up of the book are good.

A Laboratory Manual of Qualitative Organic Analysis—By H. T. Openshaw. Published by Cambridge University Press, Pp. 1-95, Price 6/-

This short manual is a welcome addition to several other books on the subject. It presents logical methods for the identification of the commoner types

of organic compounds. As a result of experience the author has given standard procedures for the preparation of the crystalline derivatives of the organic compounds. Different types of organic compounds which are usually given to the students for identification have been presented in tabular forms along with the melting points of their derivation, which can be easily prepared. The book will be very helpful to the students of organic chemistry in their practical classes.

D. C.

A Practical Course in Agricultural Chemistry—By Frank Knowles and J. Elphin Watkin. Published by Macmillan & Co., Ltd., St. Martin's Street, London. Price 12*s*. 6*d*.

The subject matter is discussed under the following headings :—

(1) Soils ; (2) Fertilizers and manures ; (3) Plant and animal bio-chemistry ; (4) Feeding stuffs ; (5) Dairy products ; (6) The chemical examination of water ; (7) Insecticides and fungicides.

Sir John Russell says in the foreword that the authors have "a wide knowledge of the educational needs of agricultural students" and have "the further advantages of being themselves research workers in soils and plant growth". "The treatment is throughout sufficiently elementary for the young student, yet it has been so designed that he will have nothing to unlearn if he elects to take up a scientific or advisory career." "The book will be of great help to agricultural students." It covers within its scope fairly completely the diverse types of measurements with which students of agricultural chemistry should be familiar.

A number of mis-prints have been noticed, which, it is hoped, will be removed in the next edition. The section under electrometric method contains a misstatement as regards the theory of the E.M.F. of the hydrogen electrode, "It follows that a measure of the resistance can be used to measure the concentration of hydrogen ions. For this purpose the resistance is balanced against a known variable resistance, by an instrument known as a potentiometer". It is hoped that this section will be re-written in the next edition.

The book is obviously meant to be elementary. But it seems to the reviewer that the authors should have devoted a little more space to quantitative measurements.

The book can be recommended for the general student of agricultural chemistry.

J. N. M.

Theoretical Chemistry—By Samuel Glasstone, Professor of Chemistry in the University of Oklahoma. Published by D. Van Nostarand Company, Inc. 250 Fourth Avenue, New York. (Distributor in India—Messrs Macmillan & Co., Ltd.), Pp. 515 (Third Printing). Price 31/6.

The author intends to supply a first hand knowledge to the students of chemistry in the modern portions of Theoretical Chemistry and the popularity of the book is evident from the appearance of three editions within a short period. Wave mechanical treatment of valence and associated atomic and molecular properties and elements of statistical thermodynamics are introduced in a less rigorous but more formal way, just to enable the learner, whose knowledge in mathematics is confined to a few elementary differential equation only, to grasp easily some of the modern approaches to the chemistry of molecules. The intentions and purposes of the book are stated by the author in the preface: "It can not be claimed that the treatment given here is comprehensive or completely rigorous. This book alone is not necessarily sufficient to supply the detailed instructions which would permit the reader to use quantum mechanics and statistical mechanics as tools for himself. Its primary object is to help him understand clearly how they have been employed by others to obtain results of chemical significance." This object is fulfilled in this book.

The chapters are: Introduction (Quantum Numbers), Quantum Mechanics, Quantum Theory of Valence, Molecular Spectra (Diatomic molecules), Molecular Spectra (Polyatomic molecules), The Electron Configuration of Diatomic Molecules, Statistical Mechanics, Statistical Thermodynamics and Inter molecular Forces. In general the book covers a wide field and gives a consistent picture of the methods generally used.

The Introductory chapter is specially suitable to a young learner as it specifically clarifies the current nomenclature about electrons in atoms and atomic levels. The statement that "the principal quantum number may either be zero or in figures", is however somewhat erroneous, as it has neither physical nor mathematical significance. This fact has, however, been clarified partly in page 56. The subtle difference between 'metastable states' and 'excited states' is, however, not apperent from the text.

The real chemical part begins from Chapter III which gives an account of "Quantum Theory of Valence". Starting from elements of 'Variational method' current in Wave Mechanics, London-Heitler theory of hydrogen molecule is developed with sufficient material and suitable references to the later refinements of the theory. Ideas of resonance, spin effect functions, directed valence bonds, etc., are

discussed elaborately and some applications to systems of several electrons are given. Chapters on Molecular Spectra deal with practically all the necessary features of molecular spectra, *e.g.*, Vibration spectra, Vibration-Rotation spectra, Frank Condon principle, Predissociation, Raman spectra, etc., along with the finer modifications like isotopic effect, and nuclear spin effect on the spectra of molecules.

The statistics of Maxwell-Boltzman, Bose-Einstein, and Fermi-Dirac are discussed in details and the equations of states for particles obeying these statistics are obtained; cases of degenerate systems have also been included. Discussions on partitions function is a special feature of the chapter on 'Statistical Thermodynamics'. More elaborate treatment of the Third Law of Thermodynamics would have been better appreciated.

The author has also given an account of 'Quantum Theories of Intermolecular Forces' and theories of highly compressed state, but theory of liquid state is avoided.

The bulk of the subject matter and the simpler presentation will prove to be of much help to the workers in theoretical chemistry and the book is highly recommended for the degree course in Physical Chemistry.

B. K. B.
U. K. G.

24th and 25th Annual Reports of the Indian Central Cotton Committee, 1944-45 and 1945-46

The 24th and the 25th Annual Reports of the Indian Central Cotton Committee contain interesting records of the activities of the Committee in spite of the numerous handicaps encountered due to the war.

The aims and objects of the Committee have been enumerated in the first chapter of the latter report but one is not sure whether the accomplishments of the Committee have been proportionate to the expenditure (see appendices).

On the *Technological side*, it has been mentioned that suggestions were offered to the mills to enable them to "make the best possible use of their cotton". But how far these suggestions were carried out by the mills or what were the methods employed by the Committee in enforcing them, if necessary, are not mentioned. In India both the Industrialist and the Agriculturist look upon the Scientist with a certain amount of suspicion and there is little co-ordination between them, and very often the former thinks that the ideas of the latter are either not practicable or paying.

The results of an experiment in mixed cultivation of 43F and C520 in different proportions deserve special mention. It was found that the mixtures had better qualities than the pure types. If this can be established in other types also, means should be devised in enforcing the cultivator to grow mixtures without detrimental effects on the types themselves.

Apart from the routine spinning and other tests on the sample supplied by the Provincial Agricultural Departments, certain experiments were carried out by the Technological laboratories on various types of gins and others of practical value to the industry but their importance cannot be assayed immediately.

On the *Agricultural side*, a great increase in the average acre yield has been claimed. Thus from 96 lbs. in the quinquennium of 1922-27, it increased to 109 lbs. in 1837-42 and to 112 lbs. in the triennium 1942-45.

In the section dealing with Cotton *genetics* and *physiology* certain fundamental research problems like fuzz inheritance in *Gossypium hirsutum*, and inheritance of lint colour in certain other types are worth mentioning. It has been stated that Jassid and Wilt resistant types were selected in the Upland types and further work is in progress. If these selections should combine the resistance with good yield then it is certainly good achievement.

Certain improvements in the lint length and ginning percentage have been reported by the action of X-rays on the seeds. This appears to be a useful line of investigation and should be conducted according to a definite programme.

Mention is also made of interspecific hybridization experiments. Apparently the failures are far too many in the subsequent selections and it may be worthwhile to find out the causes of that.

The effects of spacing and manurial treatments are interesting. Vernalization appears to have given contradictory results.

The statistical side has not also been neglected. It is reported that a discriminant formula for selecting superior yielding types has been developed and mention is also made of suitable lay-outs for replicated progeny row trials. These may help the Provincial Departments to a great extent.

In the chapter dealing with cotton research in the Provinces and States, one finds that good results have been reported from Bombay, Sind, Punjab and Madras.

In Bombay province the Broach and Jalgaon Cotton breeding schemes had to be modified as per the revised policy of the Committee. This has resulted in a considerable loss of time and money and could have been avoided by proper planning. But the scheme for interspecific hybridization at Surat has yielded good results.

The experiments in Sind for producing long stapled cotton have yielded good results and here one feels that the results have been well worth the expenditure.

In Punjab, the schemes for the improvement of cotton in Jhang district, the south eastern districts and the Lower Bari Doab canal colony (off-shoots of the original Punjab Botanical scheme of 1925), although sanctioned by the Committee comparatively recently can be expected to yield good results in view of the past achievements of the Province. But how far the physiological scheme also sanctioned in January, 1944 will aid the cultivator, has yet to be seen.

In Madras, the schemes for the improvement of Mungari Cotton, Cocanadas and the breeding of Cambodia Cotton in the ceded districts, recently approved by the Committe, fulfil a long felt want.

In the Chapters dealing with the progress of the introduction of improved varieties of cotton it is interesting to find that Bombay has 1,138,000 acres under improved varieties out of a total of 2,017,000 acres; Sind 784,000 out of 867,000; Punjab 2,352,000 out of 2,955,000; Madras 951,000 out of 1,584,000; C. P. and Berar 2,161,000 out of 2,865,000 etc. These figures are illustrative of the excellent co-ordinated work of the Committte.

It appears that the Committee has so far spent Rs. 20½ lakhs in seed distribution and extension work. This amount should be considered as money well spent as it forms the real link between the Experts and the Cultivator, and as the latter is given a chance to judge how far the improved strains are useful to him. The Provinces and States mainly benefitted by this are Bombay, Sind, C. P. and Berar, U. P., Baroda and Mysore. In this connection it is regrettable to note that Bengal has so far received only a step-motherly treatment from the Committee. This is not the occasion to apportion the blame between the Provincial Government and the Committee but it is high time the latter felt that Bengal is also entitled to a fair share of its affection.

In the Chapter on cotton statistics it is stated that for the year 1945-46, the total area under cotton in India was 14,478,000 acres showing a decrease of 365,000 acres or 2·5 % as compared with the previous year. This reduction has been mainly due to the "Grow more food" campaign of the Government, coupled with the policy of the Committee to reduce the area under short and low grade medium stapled cotton.

The exports of cotton during the year amounted to 1,035,000 bales as against 406,000 bales in 1944-45, representing 2·5% of the total value of exports of "raw materials and produce and articles mainly unmanufactured".

The difference between cotton forecasts and the estimated actual yield in 1944-45 amounted to 22% and proposals have been made to minimize this error. The figures for 1945-46 should prove whether the steps taken had been in the right direction or not.

Chapter VI deals with Cotton Marketing, Legislation and other protective measures and it is interesting to note that the Committee had already made recommendations to the Government of India for the relaxation of the restriction in exporting cotton below 1·3/1·6" staple length. This should prove a great blessing to the short stapled cotton growing tracts.

One of the glaring injustices done to the Indian Cotton Industry as a whole was the action by the British Government in buying the Sudan Cotton and selling it in India at double the price, while at the same time giving it at a cheaper rate to the Lancashire Mills. The Committee brought this to the notice of the Government of India and requested them to see that in future the Sudan Cotton is sold both to the Indian and to the Lancashire Mills at the same price. It may also be mentioned that the Committee is trying to prevent the introduction of foreign pests like the Mexican boll weevil, the Red boll worm etc., by proper legislation.

There are five appendices to the report for the year 1945-46 giving the names of the members of the I.C.C.C., its sub-committees; the receipts and payments; stocks of Indian Cotton held by mills and the Indian raw cotton consumed. If names and the positions of its members mean anything, certainly the Committee has a long and dignified array of them. But in spite of the useful work claimed to have been done by the Committee, one is inclined to think that the administrative and other expenses are a little out of proportion to the amount spent in research and other aspects of practical value to the Cultivator and the Industry.

K. T. J.

LETTERS TO THE EDITOR

[The Editors are not responsible for the views expressed in the letters.]

STATISTICAL ESTIMATE OF TIME SAVING DUE TO DECIMALIZATION OF COINS, WEIGHTS AND MEASURES IN INDIA

WITH a view to observing whether there would be real saving in time by the proposed Decimalization of Indian Coins and Weights, an experiment was conducted by taking up a few Arithmetical problems on Addition, Multiplication, Division and Compound Practice. Eight examples of each type in both the present and the proposed system were considered and separate times for computation were recorded in each case. It was however, observed that almost each problem of the present system takes less time by the proposed decimal system. This is a strong evidence of gain in time by the decimalization of the system of coins and weights. Statistical tests of significance on this observed difference in time also confirms the above conclusion.

In consideration of the total time consumed in all the eight examples in each case, percentage of saving in time by the proposed decimal system has been calculated. This is shown in the last column of the following table. It is found that nearly 55 per cent of the time spent after problems on Multiplication (involving coins) in the present system may be saved by the adoption of the proposed decimal system. In case of Addition (coins and weights) nearly 29 per cent, Multiplication (weights) nearly 27 per cent, Division (coins & weights) nearly 20 per cent and compound practice nearly 19 per cent of time may be saved.

TABLE

TABLE SHOWING THE SUMS OF RESULTS IN THE EXPERIMENTAL STUDY OF THE ADVANTAGE OF PROPOSED DECIMAL SYSTEMS

	D.F.	t	Approx. P.*	Percentage of saving in time
1. Addition—Coins ...	7	4·58	·003	29·16
2. Do. —Weights ...	7	2·82	·010	29·09
3. Multiplication—Coins ...	7	4·07	·003	35·21
4. Do. —Weights ...	7	3·37	·005	27·27
5. Division—Coins ...	7	1·32	·100	19·22
6. Do. —Weights ...	7	2·57	·025	20·00
7. Compound Practice ...	7	3·83	·005	18·92

* Probability being calculated approximately from the positive tail of the curve only.

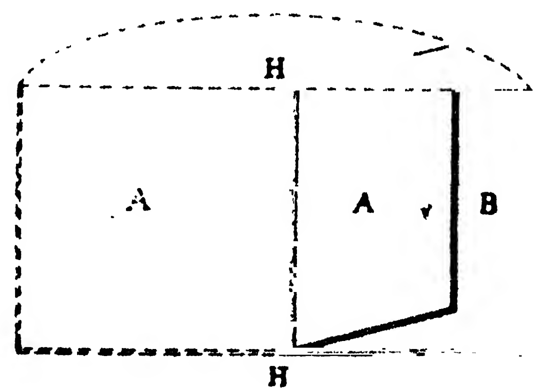
Student's 't' test was applied and the probabilities (calculated approximately from the positive tail of the curve) for containing the observed value of 't' or a less value, will be found in columns 2-4 of the above table. Significant difference in time is revealed from these figures. Details will be discussed in a subsequent communication.

A. K. GAYEN

Statistical Laboratory,
Calcutta, 19-8-1947.

PREPARING LANTERN SLIDES WITHOUT PHOTOGRAPHY

SOME simple, handy and economical methods of preparing, on ordinary glass, of text-book figures line diagrams, formulae etc., were described in *Nature*[1, 2, 3, 4, 5]. I am, however, using a method which is both simpler as well as more convenient and economical. The results also are highly satisfactory. For drawing or copying diagrams etc., I use tracing paper or 'Cellophane' in place of glass. The tracing paper employed is marketted under the name of



"Butter paper". But even ordinary paper, preferably letter-paper which is thin or of medium thickness, if not already sufficiently transparent for tracing and projecting, can be made so by methods described in books of receipts, formulae etc. 'Cellophane' and 'Butter paper', however, are easily available, and on these one can write with ease with any ink and pen.

India ink, of course, is preferable. Tracing can also be done by means of a soft pencil, and these can later be inked over. If the drawings are to be preserved, 'Butter Paper' is better, since 'Cellophane' although excellent for projection purposes owing to great transparency, is fragile and liable to become easily torn.

The drawings so prepared are next placed between two lantern slide cover glasses folding, like the leaves of a book, along a hinge on one side formed by glueing a piece of thin chamois or other leather, or tape. The whole is now treated as lantern slide. After an illustration has been projected it is removed from the 'folder' and the next one inserted. A *single* folding pair of glasses is thus available for supporting and projecting any number of illustrations. Time and labour, however, are saved by using two such pairs so that while one is being used in the epidiascope, the other is available for taking in the illustration to be next projected. As a precaution against accidents it is desirable to have a couple of spare 'folders'.

By means of this simple device not only a large number of diagrams etc., can be easily, rapidly and more economically prepared, but if one wishes and can spare time, it is also relatively easy to make as detailed an illustration or tracing of a published figure, as one likes. Moreover, being light, thin and non-fragile, storage, handling and transport of a large number of illustrations, are greatly facilitated. If required, any of the illustrations can be bound and made permanent.

N. K. Tiwary

Botany Department,
Hindu University,
Benares, 23-9-1947.

1, 2, 3, 4, 5 *Nature*, 149, 327, 1942; *156*, 574, 1945; *157*, 591, 700, 879, 1946.

PREDICTION OF A NEW ELECTRONIC LEVEL OF THE O_2^+ MOLECULE

Oxygen produced by heating KM_nO_4 crystals was excited by high frequency (750-850 Kc./sec.) discharge (output power less than 10 watts) and the spectra photographed both in the visible and in the ultra-violet regions. In the ultra-violet region the second negative O_2^+ band system, the Schumann-Runge O_2 band system and many new bands have appeared. Besides these, the so-called (by Johnson) O_3 bands and the bands which Johnson[1] attributes to the O_2^+ molecule (but which do not find a place in the vibrational analysis of the second negative system of O_2^+ molecule) have also appeared. A critical study of these bands leads us to predict the existence of a new electronic level of the O_2^+ molecule. The arguments for such a prediction, are briefly indicated here.

A striking difference of nearly 200 cm.$^{-1}$ in case of the bands attributed to the O_2^+ molecule by Johnson[1] and a few others observed by us for the first time strongly suggests that they belong to some system of the O_2^+ molecule involving its $^2\Pi_g$ level. An attempt was made to accomodate these bands in the present (v', v'') table of the second negative system of the O_2^+ molecule but no satisfactory result was obtained. Similar futile attempts were made to put them in a separate (v', v'') table theoretically deducible from the known levels of the O_2^+ molecule and involving its $^2\Pi_g$ level. We therefore suggest that these bands might be belonging to some new system of the O_2^+ molecule whose initial level is not discovered as yet (the final level being the $^2\Pi_g$ level).

A survey of the mean vibrational differences for the initial states and the (O - c) values of the bands of the second negative system of the O_2^+ molecule as obtained by the previous workers and ourselves suggests the occurrence of strong perturbations in the initial level, $^2\Pi_v$, of this system at its sixth or even lower vibrational level. The only other known level of the O_2^+ molecule are $^4\Pi_v$, $^2\Pi_v$, & $^4\Sigma^-_g$; none of which fulfils the necessary and sufficient conditions for perturbing the $^2\Pi_v$ level.

[There is however a chanced coincidence of the 16th (42453 cm.$^{-1}$)* and the 22nd. (45777 cm^{-1})* vibrational levels of the $^4\Pi_v$ state with 5th (42400 cm.$^{-1}$)* and the 10th (45838 cm^{-1})* vibrational levels of the $^2\Pi_v$ state respectively. This coincidence of these level indicates some possibility of the said perturbations, but a consideration of the U(r) curves clears out any such possibility conclusively. Both these states arise out of similar separated atoms *i.e.*, $^4S_v + ^3P_g$; and as such, their U(r) curves can not cross each other (which is a necessary condition for the perturbations to set in)].

Therefore in order to explain the anamoly in the $^2\Pi_v$ state we arrive at the following two conclusions:

Either a careful revision of the structure of the O_2^+ molecule has to be made or a new level of the O_2^+ molecule has to be predicted.

Following the path of the least resistance we therefore predict the existence of a new level of the O_2^+ molecule.

From theoretical considerations we can suggest that this new level will be a Π level, preferably a $^2\Pi$ level and must arise, like the $^4\Sigma^-_g$ level, out of the dissociation-product ($^4S_u + ^1D_g$) in the separated atoms. Furthermore, this level will have an energy level near the 10th or even still lower vibrational level of the known $^2\Pi_v$ level and the potential energy, U(r), curves for the known $^2\Pi_v$ level and this pre-

* These values have been given with reference to the $^2\pi_g$ level of the O_2^+ molecule.

dicted level will cross each other near this common level.

Our thanks are due to Prof. R. K. Asundi of the Benares Hindu University under whose guidance the work has been done.

LALJI LAL

Department of Physics,
D. A. V. College, Kanpur,
27-11-1947.

[1] Johnson, *Proc. Roy. Soc.*, *105*, 683, 1924.

ON THE DESIGN OF EXPERIMENTS FOR WEIGHING AND MAKING OTHER TYPES OF MEASUREMENTS

FOLLOWING a paper by Harold Hotelling[1], Kishen suggested some improved designs[2], the details of which appeared in *Annals of Mathematical Statistics*[3]. The purpose of the present note is to show that alternative designs with higher efficiency are possible for a certain class of designs discussed by Kishen.

For $N=2^m+1$, $p \leqslant 2^m$ (zero bias) or $p \leqslant 2^m-1$ (if there is bias), the design suggested by Kishen is the one characterized by the matrix X, obtained from the corresponding matrix for the completely orthogonalized design (with the omission, if necessary, of its columns depending on the number of objects to be weighed) by adding a row 1, 1, ... 1 to it. The design with the same efficiency may, however, be obtained by adding *any row*, for, the determinant represented by the matrix $X'X$ remains exactly identical. That this is so will be clear from the following properties of the matrix X, showing its connection with the determinant represented by $X'X$. Let the determinant represented by $X'X$ be denoted by D.

(*i*) Any two rows of the matrix X can be interchanged without changing D. (obvious).

(*ii*) Any two columns of the matrix X can be interchanged without changing D. (This will be equivalent to changing the corresponding columns as also the corresponding rows in D).

(*iii*) Any *n th* column of the matrix X represented by the vector γ may be changed to $(-1)\gamma$, without changing D. (This will be equivalent to changing the sign of all elements except the *n th*, in the *n th* row and the *n th* column of the determinant).

With the help of the above properties, a matrix X derived by adding *any row* may be shown to change to the matrix X obtained by adding the row, 1, 1, ... 1.

For $N=2^m+r$, $p \leqslant 2^m$ (for zero bias) or $p \leqslant 2^m-1$ (for non-zero bias), where m is any positive integer and r any integer $\leqslant 2^m$, Kishen suggested a highly efficient design which is represented by the matrix X, obtained from the corresponding matrix of the completely orthogonalized design by the addition of the row, 1, 1, ... 1 repeated r times. More efficient designs may, however, be obtained by the addition of r *different rows* taken from the corresponding matrix of the completely orthogonalized design.

As an illustration, the design with $N=2^2$, $p=3$ (for zero bias) may be taken. Let $r=2$. The design suggested by Kishen is represented by the matrix.

$$X = \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & -1 \\ 1 & -1 & 1 \\ 1 & -1 & -1 \end{pmatrix}$$

The unknown weights in this design will each have a variance of $1/5\ \sigma^2$. Also, if *any row* other than 1, 1, ... 1 be repeated twice, the same variance will be obtained for each unknown.

If, however, X is obtained by adding any *two different rows*, (1, 1, 1) ; (1, 1, −1), the average variance of the weights to be estimated will be $\frac{13}{72}\sigma^2$. $\frac{13}{72}\sigma^2$ is evidently less than $\frac{1}{5}\sigma^2$. Therefore such designs are more efficient than those discussed by Kishen under this class. In the designs suggested here, the unknown weights will, however, have different precision.

The general solution of this class of designs is under communication.

K. S. BANERJEE

Pusa (Behar),
4-12-1947.

[1] Harold Hotelling, "Some improvements in weighing and other experimental techniques". *Ann. Math. Stat.*, *15*, 297-306, 1944.

[2] K. Kishen, "On the design of experiments for weighing and making other types of measurements". *Cur. Sci.*, *14*, No. 8, 194-195, 1945.

[3] K. Kishen, "On the design of experiments for weighing and making other types of measurements". *Ann. Math Stat.*, *16*, 294-300, 1945.

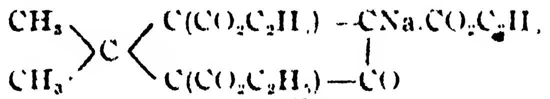
A RATIONAL SYNTHESIS OF PERKIN AND THORPE'S YELLOW SODIUM COMPOUND $C_{14}H_{21}O_{11}N$

PERKIN, Thorpe and Walker[1] prepared a yellow sodium compound, by the action of ethyl $\alpha\alpha'$-dibromo-$\beta\beta$-dimethylglutarate on ethyl sodio-malonate to which structure (I) was attributed. Subsequently, Toivonen[2] showed that the sodio-salt on methylation yielded a product which could be degraded to camphoric acid and suggested that the original sodio-salt must have the alternative structure (II). In view of these discrepancies it seemed of interest to synthesize the yellow sodio-salt by a series of reactions such that a successful outcome of the work would have a direct bearing on the constitutional problem. This has proved to be the case.

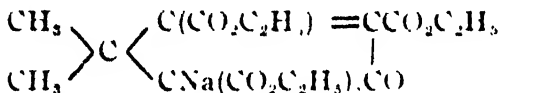
Thus it has been found that ethyl α-keto-$\beta\beta$-dimethylglutarate on condensation with ethyl malonate in presence of acetic anhydride and zinc chloride[3] readily furnishes the expected unsaturated malonate (III), as a colourless liquid. b.p. 182°/5 mm.

The latter on catalytic hydrogenation gives ethyl $\beta\beta$-dimethylbutane-$\alpha\gamma\delta\delta$ tetracarboxylate (IV). b.p. 178-180°/5 mm. and on hydrolysis with concentrated hydrochloric acid affords $\beta\beta$-dimethyl butane-$\alpha\gamma\delta$ tricarboxylic acid[4]. The unsaturated malonate (III) on brief refluxing with alcoholic sodium ethoxide smoothly undergoes cyclization with the formation of the characteristic yellow sodium-compound, which shows all the properties ascribed to it by Perkin and Thorpe. On hydrolysis with dilute sulphuric acid the synthetic sodio-salt furnishes 4:4; dimethyl Δ^2-cyclopentene-1-one-3-carboxylic acid[5]. (V) m.p. 180°, which was further characterized by the formation of the characteristic semicarbazone, m.p. 255°.

The foregoing synthesis definitely establishes the correctness of the monocyclic structure (II), for the yellow sodio-salt. The properties and reactions of a wide variety of analogous sodio-compounds, to be described later, also fall into line.



(I)



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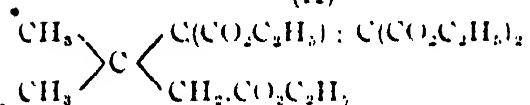

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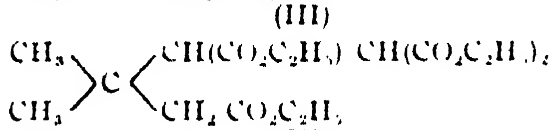
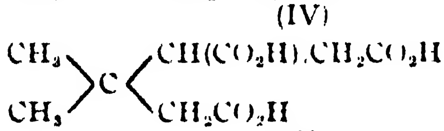
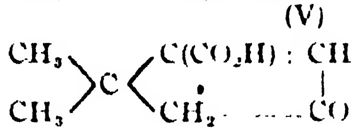


(IV)



(V)



The author desires to thank Professor J. C. Bardhan, for his helpful interest during the progress of this work.

(MISS) DEBI MOOKHERJEE

Khaira Professor's Laboratory,
University College of Science and Technology,
Calcutta, 10-12-1947.

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A NOTE ON THE AVERAGE SIZE OF THE PEPTIDE AGGREGATES IN PROTEIN HYDROLYSATES

IN a previous paper[1] on the characteristics of peptones it has been shown that the average size of the peptide aggregates in the peptic casein hydrolysate powder is 9, in the papaic powder 8, and in the tryptic powder 2 only. The nitrogen distribution in the various fractions of the different hydrolysate powders has also been determined as follows:—

Hydrolysate Powders	N_2 Distribution %						
	Proteoses						
	Primary	Secondary	Total	Peptone (a)	Peptide (b)	a+b	Free Amino Acid
Peptic ..	72·7	11·2	84	13·5	0·8	14·3	1·8
Papaic ..	27·8	40·5	68·3	18·8	10·1	28·9	2·8
Tryptic ..	6·1	32·9	39	13·2	42·6	55·8	5·[illegible]

The proportions of the nitrogen of the peptide linkages as well, considered on the basis of dry and ashless protein,[1] are found to be similar in both peptic and papaic hydrolysate powders, pointing to the fact that besides pepsin, papain also behaves like a *proteinase* in casein substrate inspite of its being activated with sodium thiosulphate.[2] Both being *proteinase* of almost same potency, it may be assumed that the average sizes of the proteoses as well as the peptones together with peptides in the peptic and the papaic hydrolysate powders would be similar. Hence simultaneously equating the proportions of the proteoses and the peptones plus peptides into their unknown average sizes, with the average sizes of the peptide aggregates of these two hydrolysate powders, the average length of the proteoses as well as those of the peptones plus peptides may easily be found out. The equations would be:

$(0{\cdot}7396 + 0{\cdot}1139)x + (0{\cdot}1373 + 0{\cdot}0082)y = 9$; $(0{\cdot}2860 + 0{\cdot}4167)x + (0{\cdot}1934 + 0{\cdot}1039)\ Y = 8$ whence x, the average size of the proteoses, is found to be 9·98 and Y, the average size of the peptones plus peptides is 3·32. If a similar equation in the case of tryptic hydrolysate powder be formulated:

$(0{\cdot}0643 + 0{\cdot}3474)x + (0{\cdot}1392 + 0{\cdot}4494)\ Y = 2$, it would be found that the average sizes of the proteoses and the peptones plus peptides cannot be similar to those in the former two hydrolysate powders. The nitrogen distribution in the different fraction of the tryptic hydrolysate and the average sizes of the peptide aggregates in the different fractions therein considered together, along with the average size of all the peptide aggregates in the hydrolysate which has been found to be 2, would indicate that the primary proteose cannot be bigger than penta-

peptides, that the secondary proteose not bigger than tetrapeptides, that the peptones are, on the average, tripeptides and that the peptides mostly dipeptides. The chemical characteristics of the protein hydrolysate powders may thus be tentatively summarized as follows:—

(1) The tryptic 'hydrolysate' contains 6·1 per cent pentapeptides, 33 per cent tetrapeptides, 13 per cent tripeptides 43 per cent dipeptides and 5 per cent free amino acids.

(2) The papaic 'hydrolysate' contains 68 per cent *eka*-peptides, 29 per cent tetrapeptides and 3 per cent free amino acids.

(3) The peptic 'hydrolysate' contains 84 per cent *eka*-peptides, 14 per cent tetrapeptides and 2 per cent free amino acids.

Further work is in progress for establishing the composition of the protein fractions.

My sincerest thanks are due to Dr U. P. Basu, for his kind interest in the work.

N. Ray

Bengal Immunity Research Institute,
Calcutta, 20-12-1947.

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WANTED: A FOREST POLICY

Forest plays such an important part in the life of the country that its importance in the economic set up of independent India hardly needs any emphasis. The Standing Advisory Committee of the Food and Agricultural Organisation of the United Nations in its second session of the conference held at Copenhagen from 2nd to 13th of September, 1946, drew up a very comprehensive report on Forestry and Forest Products. This report does not seem to have received the attention it deserves in this country in particular, where our 'forest sense' is very little developed and it is the duty of administrators, industrialists and scientific men to take up the matter in right earnest. I quote a few extracts from the report:—

"In dedicating itself to the goal of freedom from want, F. A. O must devote a major effort to restoration of the world's forests and to the effective use of their products. There is a shortage of wood despite the fact that the world has more than enough forest soil to provide wood for the earth's peoples and that with proper forest management and utilisation, enough wood could be produced to supply all existing needs."

"There is a long standing wood deficit. This shortage is all the more serious because of rising demands for wood for pulp and for a growing chemical industry. The causes of this critical stage are basic and include deforestation, inadequate forest management, failure to develop mature forests, incomplete utilisation and insufficient technical personnel."

"Deforestation has brought about total annihilation of forests over wide areas with resultant lowering of living standards, erosion and adverse climatic conditions. It has seriously affected over half the world's population. Yet these denuded areas, if reforested, and properly handled, could again become large producers of forests products."

"The rehabilitation of world's forests is a huge task, worthy of a huge effort."

In free India, we have to face many problems of extreme urgency, but tackling the forest problems of the country is none the less urgent. A common villager feels the need of the forest for cooking his daily meal, but he is quite content with burning his cow dung which should ordinarily have gone to his field for manuring it. He can never think that it is possible to grow forest near his village to supply his daily necessity. Industrialists talk of big schemes of industrial expansion depending on the supply of raw materials from the forests, but they hardly stop to think if the forest is there to supply their requirements. Medical men and pharmacists plan for manufacture of medicines in this country, but they give little consideration to the source of raw materials.

The fact is that the common man has not got the 'forest sense'. It is not his fault as he hardly sees any forest that can draw his attention to its utility or beauty except a few who live nearby. We have in this country a well organized Forest Department, but thanks to the destruction caused by men, the forests are so remote that hardly the Forest Officers and their work come to the lime light of publicity. They struggle day in and day out to conserve the forest wealth of the country against uninformed opposition. Indian Dominion Government have taken up the problem of food and agriculture of this country in right earnest, but forestry which is a most important handmaid of agriculture and one of the most important sources of raw materials for industry has not been given the importance it deserves. Sufficient stress is not given for protection of forests even for conservation of soil and water. Nowhere in the organization of different ministries of the Indian Dominion Government, a Minister for Forests is mentioned, nor in the different schemes of industrial and scientific research, forestry finds a place. Big schemes like Hirakud and Damodar valley projects are in the offing, but no forest officer was originally associated with any of them although afforestation of the drainage areas is one of the most important items in such schemes.

It is time that people realized the part forests play in the economy of the country and the Indian Dominion Government lay out a vigorous policy for expansion and improvement of forests.

R. N. I

Baripada,
Mayurbhanj State,
Orissa, 21-12-1947.

ON THE FOOD OF NINE SPECIES OF *BARBUS* OF MADRAS*

THE following nine species of *Barbus* are represented in the inland waters of the Madras Presidency:

(1) *Barbus sarana* (Ham.), (2) *B. chrysopoma*, (C. & V.), (3) *B. sophore* (Ham.), (4) *B. chola* (Ham.), (5) *B. dorsalis* (Jerdon), (6) *B. amphibius* (C. & V.), (7) *B. ticto* (Ham.), (8) *B. vittatus* (Day), and (9) *B. filamentosus* (C. & V.).

They are active but small fishes, not attaining a size above twelve inches. They feed on diatoms, algae, small crustaceans, rotifers and insects. The composition of the gut-contents of 1320 specimens is tabulated below:

	Barbus sarana	*B. chrysopoma*	*B. sophore*	*B. chola*	*B. dorsalis*	*B. amphibius*	*B. ticto*	*B. vittatus*	*B. filamentosus*
Number of guts examined	150	110	250	50	210	60	270	45	175
Gut contents ..									
Diatoms :									
Bacillaria sp. ..	...	r	r	...	f	...	f	...	r
Coscinodiscus sp.	r	c	f	...	...	f	r	f	
Closterium sp. ..	...	r	...	c	c	...	...	r	c
Cosmarium sp. .	...	...	r	r	...	r	..		...
Cyclotella sp. ..	...	...	f	...	r	f	...	f	f
Eunotia sp. ..	f			f	...	...	f		...
Fragilaria sp. ..	f	f	f	c	f	c	c	r	c
Gomphonema sp	..	...	r	...	...	...	..	...	f
Mastogloia sp. ..	c		...	...	f	...	f		r
Melosira sp. ..	c	r	f	r	...	f	...	...	f
Navicula sp. ..	...	f	c	r	c	...	c	...	c
Nitzschia sp. .	f	r	c	c	f	r	c	...	c
Pinnularia sp. ..	f	r	c	f	...	...	f	f	..
Surirella sp. ..	...	...	c	...	...	r	...	...	...
Tabellaria sp. ..	c	...	f	...	...	...	f	...	f
Algae :									
Anabaena sp. .	...	...	f	...	f	...	c	...	c
Cladophora sp. ..	r	...	...	r	...	r	...	..	..
Oedogonium sp.	...	.	r	...	r	...	f	...	f
Oscillatoria sp	c	f	f	r	.	f	c	f	f
Pandorina sp. ..	...	r		...	f	...	...	...	f
Pediastrum sp. ..	...	...	c	...	c	...	...	...	...
Spirogyra sp. ..	c	r	c	f	c	c	c	f	c
Volvox sp. ..	...	...	c	...	r	...	...	...	r
Crustacea :									
Copepods ..	f	f	c	r	c	f	c	c	c
Daphnids ..	f		f	.	f	...	c	r	f
Cypris ..	r	f	f	f	c	r	r	...	r
Rotifers :	...	...	f	...	f	..	f	...	r
Insecta :									
Diptera larvae ..	...	...	f	...	r	...	f	r	r
Hemiptera adults and larvae ..	...	...	f	...	r	r	r	...	r
Coleoptera adults and larvae ..	r	...	r	...	r	...	r	...	r
Fish remains ..	c	f	...	.	...	...	...	...	...
Mud, sand, etc. ..	c	c	f	r	f	r	f	f	r

(Abbrevations: c—common. f—few. r—rare.)

Various workers, such as Sewell and Chaudhuri[11], Wilson[12], Raj[8], Chatterjee[1], Prasad and Hora[7], Hora and Mukherji[3] and Job[4, 5], have found these species, especially *Barbus sophore* and *B. ticto*, effective and valuable as larvicides. But a critical study of the natural food tabulated above reveals that out of nine species, four do not take any diptera larvae, 2 take few and three rarely. In no case dipteran diet is common. The authors' observation thus supports the view of Sen[9] that these species of *Barbus* are not of much utility in the reduction of mosquito larval incidence. Khan[6] has observed that the utility of carp minnows as controlling agent for mosquitoes lies in their algivorous activities. Hora[2] and Setna and Kulkarni[10] have found these species, particularly *Barbus dorsalis*, useful for biological control of dracontiasis.

P. I. CHACKO
G. K. KURIYAN

Madras Government Fisheries,
22-12-1947.

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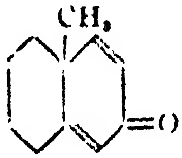
* Communicated with the kind permission of the Director of Industries and Commerce, Madras.

SYNTHETIC EXPERIMENTS ON SANTONIN

AN actual synthesis of Santonin, based on some of the preliminary experiments that have been carried out, is recorded here.

o-Methylcyclohexanone reacts with ethyl—bromopropionate in presence of zinc to give the hydroxy ester (130-35°/12 mm.) which on dehydration with thionyl chloride and pyridine gives the unsaturated

ester, (105-10°/9 mm.). The acid chloride prepared from this acid reacts with cadmium dialkyl to give the methyl ketone (105°/10 mm). This is allowed to react with ethyl formate in presence of sodium ethoxide to give the formyl derivative (deep red ferric chloride colouration in alcohol solution), which, however, failed to undergo ring closure in presence of phosphorus pentoxide to give the following ketone:



o-Methyl cyclohexanone reacts with ethyl-bromopropionate in presence of sodamide and the resulting ketoester is purified by condensation with ethyl oxalate and subsequent hydrolysis. It reacts with one molecule of bromine and the bromo compound on treatment with quinoline gives the unsaturated ester (140-45°/6 mm). This reacts with ethyl sodiomalonate to give the desired condensation product (210-20°/3 mm) which on methylation gives the corresponding methylated product (212-220°/3 mm). This on hydrolysis and esterification gives the desired keto-diester (180-90°/6 mm). It is converted into the lactonic ketoester (190-200°/6 mm) through bromination and the corresponding acetoxy derivative. For the building up of the unsaturated decalone ring, it is proposed to utilize the methods developed by Robinson and Simonsen[1]. Bromination with N-bromosuccinimide and subsequent treatment with quinoline are expected to lead to the introduction of the second double bond into the cyclohexanone ring, and work on this aspect of the problem is now in progress.

The author's sincere thanks are due to Dr P. C. Dutt, Sir Rashbehary Ghose Travelling Fellow (1947), Calcutta University, for suggesting the problem and to Prof. N. K. Sen, Head of the Dept. of Chemistry, Presidency College, Calcutta, for providing with all facilities for working out the problem in his laboratory.

PROMODE BANERJEA

Chemical Laboratory,
Presidency College, Calcutta
and
Chemisches Institut der Universität,
Zürich, Switzerland,
30-12-1947.

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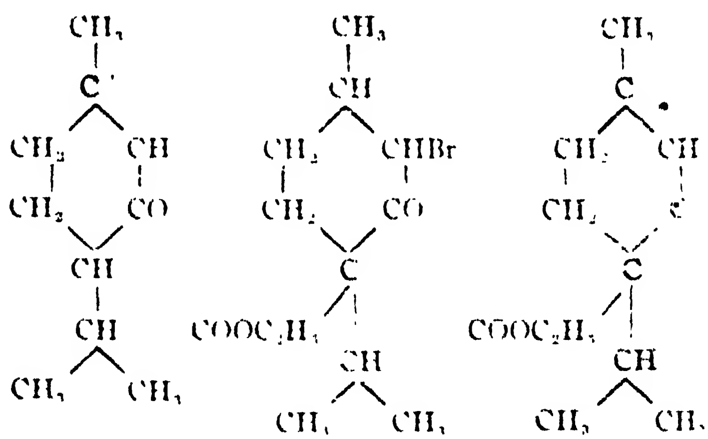
A NEW SYNTHESIS OF *dl*-PIPERITONE

PIPERITONE[1] (I) has been recently synthesized by the condensation of β-chloro-ethyl-methyl ketone with ethyl sodio-α isopropyl acetoacetate followed by saponification of the resulting product. This synthesis[2] is not, however, free from objections, since the above reaction can, obviously, proceed in two alternative ways. An unambiguous synthesis of piperitone is now described. Ethyl-2-isopropyl-5-methyl-cyclo-hexan-1-one-2-carboxylate prepared according to known methods[3] on bromination yielded a mono-bromo derivative b.p. 143°/5 mm. (II), which on heating with an excess of quinoline or dimethyl aniline at 150-60°C for a short time gave an excellent yield of ethyl-Δ'-p-menthen-3-one-4-carboxylate (III) as a colourless oil b.p. 114-115°/4 mm. The latter on prolonged hydrolysis with a mixture of concentrated hydrochloric acid and acetic acid affords *dl*-piperitone b.p. 105-106°/10 mm., which readily formed a semicarbazone, m.p. 224-225°C and agreed with all the properties described in the literature.[4]



(I) (II) (III)

The author is indebted to Prof. J. C. Bardhan for facilities in carrying out this investigation.

PIYUS KANTI CHAUDHURI

Khaira Professor's Laboratory,
University College of Science and Technology,
Calcutta, 5-1-1948.

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UTILIZATION OF FRESHLY HARVESTED POTATO TUBER IN THE CULTIVATION (AS SEED)

Potato tubers do not usually sprout if planted immediately after harvest. They pass through a dorment period varying between two to three months, after which they can sprout if planted under suitable environmental conditions. Potato requires certain temperature range, as most other vegetables, for its cultivation. In plains of India it is grown in winter, while in the northern hills where cooler temperature prevails in summer it is grown in summer too. In some such places two to three crops are raised in a year. Generally, November is the sowing time of potato in plains. Freshly harvested potatoes from hills are available in the market of plains for table purposes, from the end of October. But due to the aforesaid dormant stage they cannot be utilized in cultivation. For utilization as seeds, potato has to be stored for many months which entails huge wastage and expenditure. Consequently during the sowing time great scarcity prevails almost every year and the price sores so high that it becomes almost prohibitive to ordinary cultivators. The difficulty of the seed potato can be obviated if the freshly harvested potatoes can be used in cultivation by breaking the dormancy by suitable treatment. In that case freshly harvested potato tubers from hills can immediately be utilized as seed in the cultivation in plains.

In America Denny[1] and others have worked on breaking the dormancy of potato tubers. It has been shown that the dormancy can be shortened by different chemical, mechanical and gas treatments. Similar investigations were undertaken in this Institute and continued for the last three years. The results show that the dormant condition of the freshly harvested potatoes can be easily broken by different treatments. Cut potatoes respond more readily to such treatments than whole potatoes. Some of the results obtained in both Darjeeling red round and Nainital varieties are given in table 1.

From careful examination of the table it will be found that there is some variation between the two varieties in their responses to certain treatments. Darjeeling red round seems to have responded to ethylene chlorhydrin solution more quickly and in larger percentage than Nainital. In thiocyanate solutions Darjeeling variety sprouted earlier than Nainital. In total CO_2 also Darjeeling variety responded more quickly and in greater percentage than Nainital. In Nainital CO_2 is more effective in presence of 20 per cent Oxygen, which corroborates the observation of Thoronton.[2] That the effect of total CO_2 in breaking dormancy is not due to anaerobiosis as suggested by Quetal[3] is shown from the effect of total N_2 in both Darjeeling and Nainital varieties.

It has also been observed that in the early stage of tuber formation the period of dormancy is much less than that of the mature potato. In one of the present experiments very small immature tubers taken out of a stock of which the normal dormant period of the mature tuber was 2½ to 3 months, sprouted within 4 weeks when planted in halves. In this condition also a treatment with sodium thiocyanate shortened

TABLE I

Showing Dormancy breaking Capacity of Various Treatments on freshly harvested Potato Tubers

Variety	Treatment	Percentage of sprouting — Weeks 2	4	6	8
Darjeeling red round	1% ethylene chlorhydrin sol.	22·5	77·5	95	95
	ethylene chlorhydrin vapour 0·5 cc. per lit.	2·5	67·5	92·5	92·5
	NH_4 SCN 2% ..	2·5	85	97	97
	NaSCN 2% ..	7·5	82·5	97·5	97·5
	KSCN 2% ..	10	67·5	85	92·5
	CO_2	32·5	97·5	97·5	97·5
	CO_2 80 : O_2 20 ..	22·5	77·5	92·5	95
	CO_2 60 : O_2 20 : N_2 20	15	77·5	87·5	92·5
	CO_2 40 : O_2 20 : N_2 40	7·5	35	82·5	87·5
	N_2 ..	0	7·5	12·5	15
	Control	0	1·75	11·25	30
Nainital	1% ethylene chlorhydrin sol.	0	32·5	57·5	70
	ethylene chlorhydrin vapour 0·5 cc. per lit.	2·5	72·5	85	85
	NH_4SCN 2% ..	0	67·5	92·5	92·5
	NaSCN 2% ..	0	65	97·5	97·5
	KSCN 2% ..	0	67·5	85	90
	CO_2 .. .	12·5	62·5	67·5	67·5
	CO_2 80 : O_2 20 ..	20	82·5	92·5	92·5
	CO_2 60 O_2 20 : N_2 20	7·5	55	75	80
	CO_2 40 : O_2 20 : N_2 40 . ..	10	50	70	80
	N_2	0	10	17·5	20
	Control	0	1·25	13	25·6

Fig. 1. Photo showing dormancy breaking action of sodium thiocyanate on early immature potato tubers halved. Right, treated with two per cent sodium thiocyanate solution; left, control.

the sprouting period by about 2 weeks. A photo taken after ten days of treatment is given in fig. 1, showing how the treated specimens have sprouted by that time.

In order to verify our observation further investigations were undertaken on the period of dormancy in relation to the age of the tubers. Tubers (Darjeeling red round) of different ages from early to full maturity, were collected from the same field at different intervals of time and the periods of their dormancy were determined. Each lot was separately planted, cut in half and in intact conditions. Curves showing the time and percentage of sprouting of the whole and halved tubers at three different ages are given in fig. 2. The curves clearly indicate that the

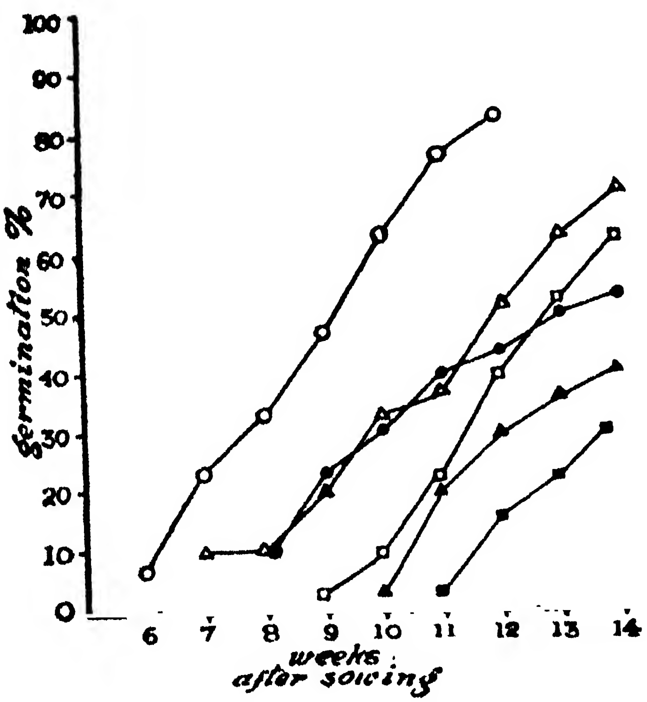

FIG. 2. Curves showing relation between age and dormant period of potato tuber in whole and half cut conditions. Age of the tuber was determined from the age of the plant. Hollow circles, triangles and squares represent half cut tubers of ages 49, 64 and 99 days respectively, black circles, triangles and square represent whole tubers of corresponding ages.

period of dormancy gradually increases with the ageing of the tuber. This is, however, contrary to the suggestion of Thoronton. According to him mature potatoes are less dormant than the immature ones; as the tuber proceeds towards maturity the periderm layer thickens which prevents the admission of oxygen and thereby brings about early sprouting. Appleman[5] and Smith[4] hold different view. According to them dormancy is prolonged by the prevention of the passage of oxygen into the tuber; facilitation of the passage of oxygen into the tuber helps in breaking the dormancy. Our observation on the dormancy of immature potato supports the view of Appleman[5]; it is less dormant because of the possibility of the entrance of more oxygen into it. But results of all other experiments cannot be completely explained by either of the theories stated above. Various theories in relation to dormancy of potato will be thoroughly discussed in a detailed publication.

Last of, all the authors suggest that though the newly formed immature tubers can easily sprout under congenial condition in the field they are prevented to do so when attached to the plant; perhaps some inhibiting hormone from the plant inhibits bud development to the attached tubers. When they are somehow detached from the plant they sprout in the field. Instances of such sprouted tubers are not very uncommon during harvest time.

B. K. DUTT,
A. GUHA THAKURTHA

Bose Institute,
Calcutta, 8-1-1948

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Anthropology and Archaeology

The Variation in Stature and Cephalic Index Among the Bengalee College Students

A. N. CHATTERJI

THE paper is based on data collected by the Medical Board attached to the Students' Welfare Committee, Calcutta University between 1922-28. Measurements of the shape of the head and stature were taken on college students from different districts of Bengal according to the standards laid down by the 'Monaco Agreement'. 15% of the measurements taken were checked by the author. The age of the students measured varied between 19 and 25, the average of the series being 20·9.

These data from different districts of Bengal have been classified into six zones—Radha, Varendra, Vanga, Chattala Samatata, and Calcutta and into five groups of people Brahmins, Vaidyas, Kayasthas, other Hindus and Moslems.

A large number of tables have been presented to show zonal variations, percentage incidence of types, group differences in different zones and zonal variations in the same group followed by discussions.

From an analysis of the data it has been found that the different groups show a great degree of resemblance in the different zones excepting in the border zone of Chattala where variations manifest themselves in perceptible degree. In explaining the factors for this remarkable resemblance the author concludes that in Bengal either the institution of caste is a later development imposed upon a people who were on the way to achieve homogeneity, or it may be that environmental conditions have in the past moulded and are still moulding the stature and the head shape of the people of Bengal to produce a common biological type.

Botany

Some Aspects of Pure and Applied Wood Anatomy

K. A. CHOWDHURY

FOREST of India contain considerable timber-wealth, of which only a part is at present utilized by the nation. In order to make the best use of this wealth it is necessary to have a clear idea of the various properties of the timbers that are available in the country. This leads us on to the study of anatomical structure of wood, which is ultimately responsible for its physical properties and working qualities.

The fundamental knowledge in wood anatomy is a pre-requisite for efficient utilization of the timber resources of a country. In this address, a general survey of our present knowledge in pure wood anatomy has been made. It is pointed out that there is still a vast field of research in pure wood anatomy that remains unexplored. Here, co-operation of the botanists working in universities is sought for expediting the research work.

On the applied side, the relation between the rate of tree-growth and the quality of timber is discussed in some detail. Based on research in India it

is generally concluded that too fast and slow grown timbers are likely to be weak and that the medium rate of growth usually produces the strongest timber. Some defects in timber, such as "Compression wood" and "tension wood", are discussed. The relation between anatomical structure and seasoning properties of wood is shown and further research on this problem is indicated. Moreover, knowledge of the anatomy of gum and resin producing trees can be of considerable help in obtaining the maximum yield without causing any permanent damage to these trees. Attention is also drawn to two important aspects of identification of timbers, namely the financial and the cultural aspects.

Finally, it is pointed out that the knowledge at present available in pure wood anatomy is not being fully utilized for practical purposes. An appeal is made to those who are responsible for our national development to put the wood-using industries on a sound foundation. To achieve that end, firstly it is essential to know what timbers are suitable for different industries and then to use only those very timbers and no others. Secondly, it is necessary to classify each timber into different grades based on its anatomical structure. After all, no wood-using industry can possibly produce standard finished articles until and unless it used standard raw materials.

Chemistry

Rice

B. SANJIVA RAO

THE address deals with the principles underlying methods of curing rice, to conserve vitamins and to secure improvement in the storage and cooking quality of the cereal. Freshly harvested paddy cannot be satisfactorily husked. It has to be kept for several weeks before it can be husked without serious loss due to breakage of grain. Rice from fresh paddy does not cook well and also causes on eating, digestive troubles. The nature of the changes that take place in the rice when fresh paddy is stored, are discussed. A valuable method for the curing of rice—the parboiling process has been in use in India from a very long time. It consists in soaking paddy in water for 24 to 72 hours and then boiling the paddy in water or heating it by steam to gelatinize the starch. During the soaking the vitamins and certain nutrients present in the bran layers move into the endosperm and get firmly fixed when the starch is gelatinized. Parboiling renders easy, the husking of paddy. The grain gets hardened. Milling losses are thus reduced. Since the vitamins present in the bran layers and the germ, have been moved into the interior of the grain parboiled rice is far less attractive to weevils than undermilled or hand-pounded rice wherein the weevils have easy access to the vitamins, present at the surface. Rule-of-thumb methods are still being used in the parboiling process, parboiled rice therefore has often got an objectionable odour and uninviting taste. Suggestions for the improvement of the process and for its standardization are discussed. The improvements consist in using water at 70°C for the soaking and reducing the period of soaking to a few hours. It is suggested that sun-drying of paddy should be given up and suitable driers used instead. Moisture in the cured rice should not be allowed to exceed 12 per cent. Recent modifications of the parboiling process, used in America for the large scale curing of rice are described and their suitability for adoption in India discussed. These methods are (1) the rice conversion process and (2) the Malek process. Details are given of a process developed in Bangalore for the curing of rice. The product obtained by this process calcured rice—has the appearance and the cooking quality of raw polished rice while having all the desirable features of parboiled rice. Vitamins are leached out of calcured rice to a much smaller extent than from parboiled rice. Calcured rice offers greater resistance to insect attack than does parboiled rice. The process is very simple and consists in soaking the paddy for two hours. in a dilute solution of calcium chloride and then gelatinizing the starch to the appropriate extent.

Engineering and Metallurgy

Some Developments in Ferrous Metallurgy

N. SEN

FOCUSSING due attention on the assistance rendered to the progress in metallurgy by the advances in scientific knowledge and technique, the address has been designed to provide stimulus to the metallurgists and interest to the engineers. The increased and increasing demand for metals, which form the chief material basis for the industrial civilization and the extremely significant place of ferrous materials therein have been stressed in the introduction. The developments dealt with relate broadly to increasing the efficiency of production and improving the quality of the products.

Direct reduction processes, electric smelting, blast furnace operations, bessemer processes, open hearth practice and rolling mill technique have all been covered. Improvements in ore preparation and the introduction of acid burdening, production of "Killed" bessemer steel and the development of the H. P. N. process, possibilities of the "all-basic" open hearth furnaces and the use of oxygen in blast furnace and open hearth have been outlined. Advancements in the casting and forging techniques and the extension of the rolling mills to the manufacture of weldless tubes and the modern hot strip mill have also been dealt with.

Under control work connected with the manufacture of quality steels reference was made to the improvements in gas and chemical analysis, microscopic and X-ray examination and the application of magnetic and supersonic methods. Advanced metallurgical studies connected with solidification of liquid steel, heat treatment, isothermal transformation, hardenability, making permanent magnet steels by the powder metallurgy technique, and the development of high permeability materials have been dealt with in some detail. The manufacture of various types corrosion and heat resisting steels and the importance of "creep" were next taken up and the existing information summarized. The concluding section dealt with X-ray and electron diffraction methods and the technique of X-ray crystallography and the increasing application of theoretical physics to metallurgical problems. The address was wound up with the following observations:

"Metallurgy existed as an art thousands of years before it was furnished with a scientific basis, and in some branches skill and empirical knowledge still outweigh scientific understanding. It is at an exciting stage of development in which broad based generalization like those existing in the older sciences had not emerged. The field is ripe for great advances in the formulation of general principles, for a wealth of uncorrelated experimental material exists. We can look forward to a period in which the nature, structure and behaviour of metals are so well understood that alloys can be designed with certainty for new applications with little development work. Simultaneously, possibilities are attractive for getting better service from the present alloys as their nature and treatment are understood and for stopping the wastage of our limited natural resources by proper utilization of the alloying elements."

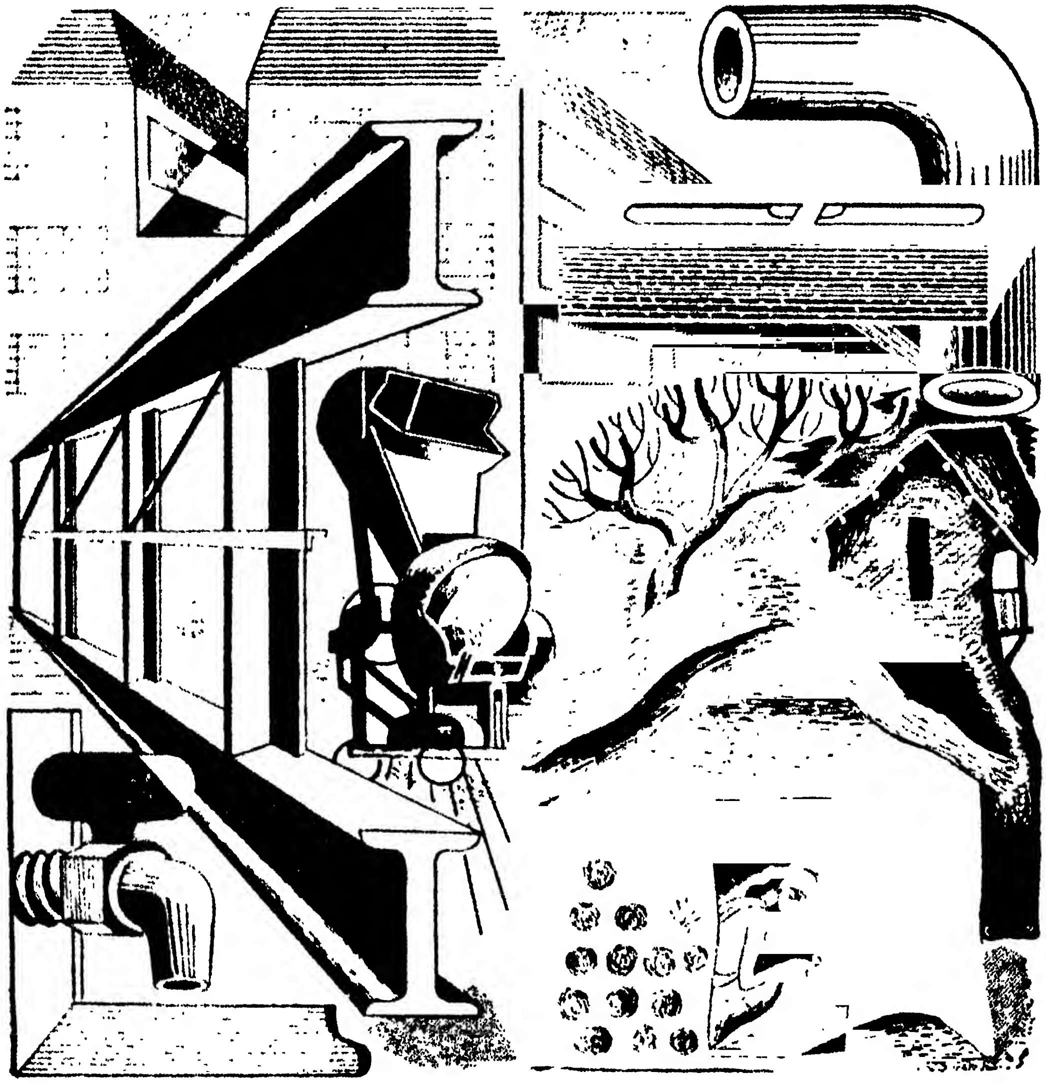
Medical and Veterinary Sciences

Blood-Fluke Problem in India

G. D. BHALERAO

DR BHALERAO, who is a recognized authority on parasitology, gave a very comprehensive and concise account of all the work done up-to-date on the blood-flukes of men and domestic animals in India. He remarked that the blood-flukes rank foremost in undermining the health of almost all domestic animals in India and cause much inconvenience and harm to our live-stock and inflict considerable monetary loss upon stock-owners. He stressed the importance of control and, if possible, extermination of this class of parasites particularly at this juncture when there is an acute shortage of food all over the world and "Grow More Food" is the stock phrase of the authorities concerned. He reviewed critically the problem of the urinary blood-fluke disease of man becoming endemic in India and finally expressed the opinion that such a hypothesis is not warranted in view of the clinical, epidemiological and experimental data obtained so far. He referred to his own investigations on the skin lesions produced in men in the Mysore State by the larvae of blood-flukes of non-human origin He devoted much attention to blood flukes of domestic animals including camels and elephants, which cause severe anaemia, diarrhoea, paralytic symptoms, swelling underneath the jaw and around the neck, emaciation, persistent debility and liver affection leading finally to the death of affected animals. Adequate attention has also been paid to the blood-flukes which cause the snoring disease of cattle and produce dysentery in dogs and pigs. In the known cases references have been made to the life-cycles of blood-flukes, indicating the snail vectors which harbour the larval stages of the parasites. Serological as well as other methods of diagnosis of blood-flukes and their treatment have also been dealt with. Finally Dr Bhalerao advocated control of blood-flukes by destruction of snail vectors by chemical, biological and mechanical means and by the treatment and proper disposal of the excreta of affected animals. Such measures will not only eliminate blood-fluke disease but will also exterminate other fluke diseases of men and animals in this country.

VISION IN STEEL



Housing the rural, urban and industrial population of India is today of such importance that the Government have undertaken to finance a large-scale housing programme.

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PUBLIC SERVICE COMMISSION, WEST BENGAL

No 4. Applications are invited by the Secretary, Public Service Commission, West Bengal to fill the post of Rural Distribution Engineer in the Electricity Development Directorate under the Government of West Bengal. Candidates must be nationals of Indian Dominion by birth or by domicile. Persons of Indian descent or citizens of the Indian States or of the Pakistan Dominion are also eligible but a declaration of eligibility issued by the Government of the Dominion of India will be necessary in their case before appointment. Pay—The scale of pay is Rs. 1,150—75/2—1,300. The appointment will be made on contract for three years in the first instance. Qualifications—A candidate must (*i*) possess a degree or diploma in Electrical and/or Mechanical Engineering of a recognised University or Technical College : (*ii*) have at least ten years experience in the lay out and costs of overhead transmission and distribution systems up to 33 K.V. and be well versed in arrangements for the protection of overhead lines and small transforming sub-stations and have thorough knowledge of all the factors which make up the costs both capital and operating on 11 K.V. and 33 K.V. Rural Distribution system : (*iii*) be fully conversant with the type of loads which may be expected in a rural area and have knowledge as to the rates which such rural processes can afford to pay for power. Particulars and application form obtainable from the office of the Secretary, Public Service Commission, West Bengal, Anderson House, Alipore, Calcutta, personally or on sending an addressed envelope with a nine pies stamp affixed. Candidates who are unable to obtain copies of the prescribed form may apply on any printed or typed form, a sample of which was published in the Calcutta Gazette of the 21st November, 1946. Closing date for receipt of applications with a treasury chalan for Rs. 5/- under the head "XXXVI-Misc.—Provincial Receipt", 31st March, 1948. Cheques or money orders are not accepted. Canvassing will disqualify.

PUBLIC SERVICE COMMISSION, WEST BENGAL

No. 6. Applications are invited by the Secretary, Public Service Commission, West Bengal, from male candidates to fill a post of Professor of Physics at the Presidency College, Calcutta in the Bengal Senior Educational Service. Age must not be over 35 years on 1st March, 1948, but may be relaxed in the case of a candidate possessing exceptionally high qualifications. Pay—Rs. 300—1,000. The initial pay of the selected candidate will be fixed on the basis of his age. Qualifications—A candidate should possess a first class degree in Physics or Pure Physics of an Indian or Foreign University. He should also produce evidence of having conducted and directed research work in Physics and of having had experience of teaching Physics to Honours and/or Postgraduate classes. A doctorate degree and experience of organisation and administration of an Advanced Physics Laboratory will be considered additional qualifications. He must be a British subject or have been made eligible by declaration under section 262 of the Government of India Act, 1935 to hold such post. Particulars and application form obtainable from office of the Secretary, Public Service Commission, West Bengal, Anderson House, Alipore, Calcutta personally or on sending an addressed envelope with a nine pies stamp affixed. Candidates who are unable to obtain copies of the prescribed form may apply on any printed or typed form, a sample of which was published in the Calcutta Gazette of the 21st November, 1946. Closing date for receipt of applications with a treasury chalan for Rs. 5/- under "XXXVI-Misc.-Provincial Receipt", 20th March, 1948. Canvassing will disqualify.

SCIENCE AND CULTURE

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SCIENCE AND CULTURE

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INDIAN SCIENCE NEWS ASSOCIATION

TO DISSEMINATE THE KNOWLEDGE OF SCIENCES AND ADVOCATE THE APPLICATION OF THIS KNOWLEDGE TO A PROGRAMME OF NATIONAL WELFARE.

Vol. 13, No. 9] [MARCH, 1948

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SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. 13 MARCH 1948 No. 9

In Memoriam

MAHATMA GANDHI, the Father of the Indian Nation and one of the most outstanding figures in the history of human civilization, who symbolized in himself all that are highest and noblest in human nature, laid down his life on Friday, the 30th January, at 5-30 P.M., at New Delhi, the capital of India, under inconceivably tragic circumstances. To India, dripping with blood and stained with diabolical crimes, this event has become a dreadful calamity of incalculable magnitude, and to a war-scarred, power-mad and hungry world it has been a grievous loss with little hope of ever being retrieved in generations to come. For, such men are born only at intervals of centuries. History records the career of three other kindred and illustrious spirits, who, too, courted death like him for the good of others. They are: Socrates, the wise Greek philosopher, Jesus Christ, who is adored as the saviour of mankind, and Abraham Lincoln, President of the United States of America, whose concern for the negro slaves made him an enemy of a section of the white people. And if one is permitted to go further back in time, one may recall the name of that pre-eminent figure, Srikrishna of the age of *Mahabharata*, who, being unable to bring back to sanity the members of his own dynasty (Jadavas), engaged in a ruinous and drunken riot, fell a victim to the arrow of a wandering hunter. Like his compeers of undying fame, Mahatmaji led an eventful life without rest, which gave him greatness in the world, while death has now bestowed on him immortality in history.

Mohandas Karamchand Gandhi was born on October 2, 1869, at Porbandar in Kathiawar of a very respectable middle-class pious Hindu family of Vaishnavite sect. From his early life he had a frail physical frame, but a powerful mind and a kindly heart. What was there in this little man that he was named and looked upon as Mahatma, or the noble soul, by his country men, and that the world today mourns his loss and pays its respectful homage to him as the greatest man of the age? In the beginning of his career his only title to public recognition, if it be called a title at all, was his membership of the English bar and a none too lucrative legal practice in the Union of South Africa. But the seed of greatness in him did not take long to

sprout and grew rapidly into a mighty tree, under the cool and refreshing shadow of which the stricken humanity found solace, shelter and peace. The very first notable event of his life sent a moral thrill through the thinking mind, when he faced with complete non-violence the mad violence of an angry white mob in South Africa. He was pelted and assaulted by the crowd almost to death; for he championed the cause of the Indian residents, who were subjected to untold indignities and denied the elementary rights of man by the ruling white race for the only fault of their having a coloured skin. When on the initiative of Mr Chamberlain, the then Secretary of State for Colonies, the Natal Government moved to prosecute the assailants, Gandhiji, true to his cult of non-violence and love, refused to identify them or sanction their prosecution. It was there that he first developed his idea of non-violent non-cooperation and led a movement in 1906 for the repeal of the fingure-print regulation, dubbed as the "Black Act". The name Satyagraha, which means attachment to truth, was chosen for this movement. All non violent movements and actions, since then initiated by Gandhiji or his followers against any individual, social or political grievances or wrongs, came to be known by this name. The struggle against the "Black Act" lasted for several years in course of which the Indians had to suffer much, and which led to the arrest of many of them including Gandhiji himself. But ultimately the South African Government had to give way, and the Indians won their point. Gandhiji, with his followers, had, however, to offer Satyagraha again on two subsequent occasions as a protest against the iniquitous and invidious legislations, like the Act prohibiting the entry of Asiatics into Transvaal and the Act taxing the indentured labourers. On each of these occasions Gandhiji and his followers, numbering hundreds and thousands, were arrested and sentenced to various terms of imprisonment. In the prison, on one occasion, one of his followers —a sturdy Pathan, thinking that Gandhiji had misled them into great hardships and sufferings for some purpose of his own, made a severe assault on him that left him almost dead. Gandhiji, however, survived miraculously and refused to give evidence against the assailant when summoned by the court. That Pathan, thereafter, became a very great and devoted admirer of Gandhiji and used to follow him everywhere as his personal guard. Non-violence thus triumphed over violence. Finally, the Satyagraha campaign in South Africa came to a victorious termination as a result of the Gandhi-Smuts Agreement in 1914, when the Indian Relief Act was passed, repealing all the obnoxious Acts and meeting the demands of Indian settlers in full.

Gandhiji returned to India in 1915 and stayed in Ahmedabad where he established a Satyagraha Asram at Sabarmati. In this Asram a rigid observance of moral, mental and physical discipline was prescribed for the inmates, who had to live a very simple life discarding all luxuries in respect of dress, food and housing. They, including Gandhiji, dwelt in mud-built huts, wore handspun clothes, cooked their own food and did all other manual work. The diet was strictly vegetarian, excluding even eggs. There was absolutely no distinction of caste, creed, colour or religion in the Asram. Attendance at congregational prayer conducted by Gandhiji at a fixed time every day was compulsory. Towards the later period of his life Gandhiji used to hold these prayer meetings punctually wherever he might have been and even while travelling in trains. He, however, did not rest long at Sabar-

mati and soon went out on an extensive tour throughout India in order to obtain first-hand experience of the conditions of suffering masses, particularly of peasants and labourers. He used to travel always as a third class passenger, so that he might feel and share the hardships of the poor. Having thus acquired a thorough knowledge of the appalling poverty, unemployment and ignorance, due to social and political exploitation of the Indian masses, Gandhiji applied himself at once to the task of liberating his motherland from all bondages and joined the Indian National Congress. In a short time he became a leading figure in the Congress and gave it a new orientation, which made it an active political organization in close contact with the masses, rather than an annual gathering of intelligentsia, well-placed in society, discussing their political grievances and disabilities under an alien government. Events occurred which soon placed Gandhiji at the helm of the Congress with his insistence on Swaraj as its goal. Henceforward, the events of Gandhiji's life may be viewed as constituting the history of the struggle for Indian independence.

The passage of the Rowlatt Act in 1918 after the first World War, seriously curtailing the liberties of the people in violation of the promises made during the war, coupled with the inadequacies of Montagu-Chelmsford political reforms, sent a wave of discontent and disappointment throughout the country. Gandhiji declared a non-violent campaign against the Act, which led to a tension between the Government and the people, culminating in the massacre at Jalianwalla Bagh and reign of terror in the Punjab. In 1920, Gandhiji launched the first non-violent non-cooperation movement jointly with the Muslim League's Khilafat agitation, bringing into fusion the interests of the two great communities of India. During this time Gandhiji became the supreme dictator of the country, his decisions being the decisions of the National Congress. In order to identify himself completely with the poverty-stricken masses of India and to share their sorrows and sufferings, Gandhiji discarded his even simple and bare dresses, and took to his loin-cloth, which earned for him later the famous appellation of *'naked fakir'* from the England's great war-leader and fighting statesman, Mr. Winston Churchill. He was acclaimed as the undisputed and selfless leader of the country, and the people expressed their deep admiration and reverence for him by calling him Mahatma—the noble soul. The movement, however, did not remain perfectly non-violent, and there were outbreaks of violence at Bombay on the occasion of Prince of Wales's visit in 1921 and laterly at Chauri Chaura in 1922. By way of penance Mahatmaji fasted for days on each occasion and finally suspended the movement. He retired to his Asram at Bardoli, and was soon arrested by the Government and sentenced to six years' imprisonment. He served the sentence in Yeravda jail, Poona, till 1924, when he fell ill and was released. There, at the Poona Hospital, he was operated upon for appendicitis. At this time communal riots broke out in many cities of India, striking at the very root of Mahatmaji's noble dreams of Hindu-Muslim unity and a happy, peaceful and progressive India. He had barely recovered from the effect of his operation, when he undertook a fast for 21 days at Delhi to atone for the sins of his own country men.

He now placed a three-fold constructive programme before the country in order to prepare itself for the final struggle for freedom by non-violent and peaceful

means. This consisted of Hindu-Muslim unity, abolition of untouchability, and Swadeshi or development of cottage industries, particularly spinning and weaving. After some years of constructive work on this basis, Mahatmaji revived his Satyagraha movement and launched the second non-cooperation campaign in 1930 with his famous Dandi march on March 12 to violate the salt law. He was arrested and detained at Yeravda jail. A settlement, however, was arrived at after the first Round Table Conference in London, leading to what is known as Gandhi-Irwin Pact. This was followed by the release of Mahatmaji, who in 1931 was induced to attend the second Round Table Conference in London. After the failure of this Conference situation in India went on degenerating. On his return to India Mahatmaji was arrested with other Congress leaders. With the publication of the Communal Award in August 1932, Mahatmaji undertook a fast unto death for its revision. The fast began on September 20 in the Yeravda jail but was happily terminated after a few days by the signing of the Poona Pact. On May 1, 1933, he announced his decision for a three weeks' fast in connection with Harijan movement, when a week later the Government released him. He undertook this fast on March 8, 1933. At this time he suspended the mass civil disobedience movement, but replaced it by individual disobedience on their own responsibility. Under his direction it was decided that all Congress organizations would cease to exist for the time. Mahatmaji himself dissolved his Asram at Sabarmati and declared his intention of marching through the country, urging people to offer individual civil disobedience. But he was at once arrested and sentened to simple imprisonment for one year. He started another fast inside the prison for being denied the facilities of carrying on anti-untouchability work, but was soon afterwards released on medical advice. In 1934, a new Asram was established at Sevagram, Wardha, and Mahatmaji stayed there doing village work. He then retired from the Congress, though continued his connection as its adviser.

When the second World War broke out in 1939, India was made a partisan to the war without the previous consent of her people or of their representatives in the Indian Assembly. At this, all the Provincial Congress Governments under the direction of the Congress tendered their resignation, and Satyagraha was revived under Mahatmaji's leadership. In October 1940, Gandhiji started the individual Civil Disobedience Campaign with the members of his Asram. Mahatmaji was arrested, but the campaign did not cease and went on an increasing scale. India's prisons were filled up to their utmost capacity. With the Japanese attack on Pearl Harbour and Malaya, the Government released Mahatmaji and all political prisoners. Then came the Cripps' offer, which was, however, rejected. Mahatmaji issued his famous "Quit India" demand to the Government and undertook to lead the Congress for a wide-spread, non-violent struggle for the removal of British domination over India. Gandhiji and the members of the Working Committee of the Congress were arrested and detained under the Defence of India Act on August 9, 1942. This led to country-wide demonstrations and disturbances. On February 10, 1943, Gandhiji began a 21 days' fast in his detention in the Aga Khan Palace, which he survived; but here in February, 1944, he lost Kasturba, his wife and his life-long partner in all his struggles. Both in South Africa, as well as in India, she took an active part in the Satyagraha and non-cooperation movements and suffered imprisonment with him. Gandhiji

was released in May, 1944, on grounds of health. In 1946, a Cabinet Mission headed by the Secretary of State for India came to frame a constitution for India. Gandhiji played a prominent part as adviser to the Congress in all negotiations with the Mission, as also with Lord Mountbatten thereafter. He was, however, all along opposed to the division of India. Hereafter the part played by Mahatmaji in fighting the upheaval of communal passion, which revealed itself in its ugliest form of loot, arson, abduction and killing on a vast scale, followed by panicky exodus of millions of population from one part of the country to the other and vice-versa, will be narrated in the history of India in grateful words of admiration and respect. Painfully affected by the Great Calcutta Killing and the Noakhali disturbances, he undertook a walking tour of the Noakhali district in January, 1947, and like a loving father tried by reasoning and advice to bring about a change of heart between the warring communities. Some months later he also visited Bihar with the same end in view, where a communal outbreak had just occurred. In the city of Calcutta, where the communal tension persisted for over a year with occasional outbursts, the Mahatma resorted to a fast in September 1, 1947, and succeeded miraculously to restore sanity among the hostile elements.

Mahatmaji's demand was satisfied when the British did quit India on August 15, 1947 ; but before leaving they divided the country into two parts and transferred power to two different governments. The result was an increase of bitterness and hatred in the land, already in the grip of a fanatical and barbarous conflict, revelling in mad orgies of unspeakable savagery and monstrous brutalities. Mahatma's vision of unity, prosperity, peace and happiness in the country seemed to vanish once for all. This was too much to bear for his kind and sensitive heart.

After a communal disturbance at Delhi he undertook his last and the 17th fast there on January 13, 1948, to establish peace and amity between the Hindus and the Muslims. The fast was broken after five days when a Peace Committee formed for the purpose gave him the necessary assurance. On January 20, while engaged in prayer, he escaped unhurt an attempt on his life, when two bombs were thrown at him by a mad fanatical youth. But he did not survive long ; for, only ten days after, on his way to the prayer ground this great apostle of non-violence sacrificed his life to the violence of a young assassin, who fired three shots into his frail physical frame from a very close quarter.

It may be said without any fear of contradiction that the history of India for the last thirty years is practically a chronicle of Mahatma Gandhi's life. He is, therefore, most appropriately called the Father of the Nation ; and, in fact, the people of India had long been used to call him as "Bapuji"—the father.

Throughout his life all his thoughts, words and deeds were meant for the service and good of others. He required very little for himself excepting his homespun loincloth and a scanty daily fare of goat's milk and fruits. He tried to realize the truth and God, as these to him were synonymous, through service of men. And this service, according to him, is best rendered through humility and Ahimsa (non-violence), without which there can be no salvation for a man. To quote his own words: "Ahimsa is the farthest limit of humility, and one must reduce himself to zero".

Mahatmaji was indeed a saint, but he did not take refuge in cloistered aloofness of self-centred religious practices. He wanted to take others as well to a higher plane of existence, both spiritual and moral. His humility and Ahimsa, on the other hand, did not mean cowardly submission or passive endurance of wrong. His non-violence, as he always expressed it, is the non-violence of the brave,—a challenge to the insolence of the strong, and non-cooperation with the evil. Non-violence cannot, therefore, be practised by a person who is afraid to die. To quote his own words, "violence does not mean emancipation from fear but discovering the means of combating the cause of fear. He, who has not overcome all fear, cannot practise Ahimsa to perfection". Ahimsa is the positive force of love and righteousness inherent in the human soul. It means quest and pursuit of truth, to which he gave the name Satyagraha, and aims at the conquest of evil by forces of good. He had incessantly preached that evil cannot cure evil but serves only to perpetuate it; violence cannot end violence but leads only to counter-violence, producing a vicious cycle and spelling disaster and ruin. He firmly believed that there is an unseen moral order in the universe, which is not a blind force or law without purpose, and that our supreme good lies in harmoniously adjusting our life thereto; and love and non-violence are the means to that end. This was not merely an idealistic faith in him, but he lived it in his own life and advocated it not only for others, but also for all corporate bodies, social, communal, political and national. This he offered to the war-ridden world as a moral substitute for war and as a sovereign remedy for all its ills and conflicts. For, it was his unshakable conviction that there is an innate goodness in man, which, when sincerely appealed to, is bound to be effective in the end, and that the power of the soul or spirit is sure to prevail over the brute force. His ultimate powerful weapon for combating the forces of evil or violence consisted in the mortification of his own self by way of fast to atone for the sins of others. This, as revealed by the events of his life, had often worked marvels and miracles. He thus tried to awaken the conscience of men in a world where it has been stifled almost to silence.

It is often said that Gandhiji was opposed to all industrial and scientific progress in view of his uncompromising emphasis on village industries, and particularly on home-spun cloths or khadi. This was, however, quite consistent with his moral and spiritual outlook on life. For, to him, "Khadi represented human values, and man is the measure of all things; he is much more valuable and important than machineries and material goods. Economic values can no longer be thought apart from human and cultural values of life". It cannot indeed be denied that the progress of civilization should be measured not merely by the progress of science and machineries, but mainly by the progress of man.

Gandhiji lived and worked for the common men, for the down-trodden, lowly and oppressed. In spite of his constant preoccupations with larger problems of social and national interest, he would always find time to attend to the private difficulties of individual man and woman, who would approach him personally, or by letters, for his advice. He sought the realization of his own self by expanding and merging it into those of others. This was religion to him and from this arose his spiritual strength, his non-attachment and non-violence or love.

In spite of his perfect non-attachment he often expressed a desire to live up to 125. There is something very winsome about it. This meant a preparation for supreme sacrifice on his part. For, by wishing to prolong his life for the service of humanity he preferred service to his own salvation, which he had been striving after. It is said that Buddha also, while entering the gates of heaven after attaining Nirvana; was deeply moved by hearing the anguished cries of the people on earth, and then turned back to say that he would rather remain on earth till the last man was redeemed.

No truer words can be said of him than those spoken by the world's greatest scientist, Professor Albert Einstein, on Gandhiji's 75th birthday:

> *"Generations to come, it may be, will scarcely believe that such a one as this ever in flesh and blood walked upon this earth"*, to which we may now add—*and died so gloriously in so poignantly tragic circumstances for peace and good will on earth.*

Like Gautama Buddha, who was the Light of Asia, Gandhiji, while alive, was in fact the Light of India. After his death this light is no longer confined to India alone, but has spread above its geographical barrier, like the sun rising above the horizon, to illumine the mind of men all over the globe. May the noble example of his life, which he lived for us, and the memory of his glorious though tragic death, which he courted to wash our sins, inspire us and the world at large to tread the path of truth, non-violence and love, opened by him for the salvation of mankind in the midst of all enveloping darkness and death! May the supreme sacrifice of his life, like that of the sage Dadhichi of old, be utilized for forging a moral weapon, more powerful than the atom bomb, for saving the mankind from the destructive grip of the demoniac forces which reign supreme today all over the land! May the memory of his words and deeds, like ferments of goodness, grow with time to permeate the minds of men and to elevate them to higher pursuits and nobler endeavours! May his soul, which was the soul of India and which is now released from the bondage of flesh, enter into the soul of us all and liberate us from the stranglehold of fear, hatred and violence, as it has already freed us from the foreign yoke!

PROBLEMS OF INDEPENDENT INDIA (I)

THE tragic end of Mahatma Gandhi has made us all conscious that the future of 'Independent India' is full of difficulties and pitfalls, and it will be well to take stock of these in advance from as many angles as possible. Ours, of course, will be a non-emotional scientific approach. Everybody will admit that Mahatma's life was dedicated to

(i) the achievement of independence from foreign yoke,

(ii) the conservation of the political and economic unity of all provinces, states and people composing India, and

(iii) securing a higher standard of life for all the people inhabiting this subcontinent.

These ideals are not only "sacred trusts" left to us by Mahatma Gandhi which everyone of us should cherish and try to fulfil, but in our own interest they are to be regarded as the fundamental axioms and should be incorporated in the constitution of the Indian Union, and we should not, by our thoughts, speeches and actions, try to commit any violence to any of these ideals, nor the future Government of the country should tolerate any violation of these principles.

Let us now take stock of the actual situation. The 'Independence of India' is not threatened just now, but if it is ever threatened, there is not the slightest doubt that the people of India will rise as one man under competent leadership, and defeat the aggression.

Unity of India

Unfortunately, the second ideal *viz.*, the conservation of the political and economic unity of all provinces and states composing India is not being given the prominence it deserves. It was only the common hatred of foreign domination which united the different communities and people of India in the great struggle for independence. Once the independence has been achieved, the old fissiparous tendencies which divided India 200 years ago into a number of petty states always fighting with each other and incapable of combining against a common aggressive enemy, are again in action, and if this trend is allowed to develop, it is sure that we shall be faced with a catastrophe worse than anything in Indian history.

Rift in Political Unity

What are the forces which are tending to disrupt the political unity of India? These are to be found in ever-increasing insistence on provincial patriotism, attempts on the part of every province to enlarge itself at the expenses of its neighbours, and placing the so-called minorities under certain disabilities. Other factors will be considered later.

But are these measures on the part of provinces justified? If India is 'One Nation', no citizen of India can be placed under at least any 'legal disability' in whichever province or State he may reside. This should be made clear in the Constitution, but before doing so, we should analyse the 'Provincial' question dispassionately, for when feeling exists, it is psychologically unsound to ignore it or brush it aside lightly.

Elements of Nationhood

This raises to the forefront the question: What is a Nation? Is India one Nation?

Many great thinkers and political leaders have debated the first question. In 1912, Stalin wrote a pamphlet, "Marxism and the National Question", in which this question was discussed on the background of contemporary politics. This tract won the warmest approbation from Lenin and other Bolshevik leaders; and it was Stalin's passport to the Hall of Fame. Stalin's conclusion is:

> "A nation is a historically evolved, stable community of people, formed on the basis of a common language, territory, economic life, and psychological make-up manifested in a common culture."

Stalin says further:

> "A Nation, like every other historical phenomenon is subject to the law of change, has its history, its beginning and its end."

According to Stalin's criterión, Great Britain, France, U.S.A. and Japan have grown into nations out of a medley of feudal states, in the wake of rising capitalism, but neither Russia or Austria were nations, nor could grow into nations.

The question of 'Nation' came to the forefront in Soviet Russia after the October Revolution of 1917 and Stalin was given the task of solving the problem from the Bolshevik point of view with respect to the innumerable people and communities inhabiting the former Czarist Empire. His solution of the problem was regarded as a masterpiece of work, and is justified by its record now extending over 30 years. The problem here was that Czarist Russia consisted of one great nation, *viz.*, the Great Russians, dominating a number of satellite nations differing from it in language, culture, and territorial habitation, *viz.*, the Ukranians, White Russians, the various people of Caucasia (Georgians, Armenians. etc.), Mongols

Turks, Uzbeks, Tajiks, Kazaks, etc. differing widely in their stages of civilization. In the formation of the Soviet State, the former Czarist idea of forcing the Great Russian culture on the satellite nations was entirely given up, and a *multi-national state* was formed, from which even the name of Russia was dropped (Union of Socialistic Soviet Republics USSR). Every nationality composing the State was allowed to retain its language, culture and territorial integrity, and the only unifying force was accession to the communistic principles of government and recognition of the dominance of the communist party, and the principles for which it stands.

Let us take another definition. Sun Yat Sen, father of Chinese Nationalism, also distinguishes between State and Nation. He says:

"The Nationality has developed through natural forces, while the State has developed through force of arms."

Defining the *natural forces*, he says:

"When therefore we discover dissimilar peoples or stocks amalgamating and forming a homogeneous nation, we must ascribe the development to these five forces, 'blood kinship, common language, common livelihood, common religion, and common customs'."

Except for mere words, Sun Yat Sen's and Stalin's definitions are identical (if we include religion, which is not found in Stalin's) in his 'psychological make-up', and 'economic life' in Sun's "Common livelihood". Sun did not give much weight to China's Moslem and other minorities on account of their small number but he sought to fuse the inhabitants of the former Chinese Empire into one great *multi-national state*, on the basis of the Russian model, composed of the Chinese as the principal partner and consisting of the satellite countries, Tibet, Mongolia and Turkestan. But China proper has not so far been able to achieve unity, in spite of clear directions by Sun Yat Sen, because her leaders have not yet been able to agree whether the pattern of economic life should be communistic or capitalist.*

POLITICAL PATTERNS BEFORE INDIA

Let us now turn to India.

It is clear that India does not conform to any definite pattern of 'Nation' or 'State'. During almost the whole of her history, even when she appeared united under great emperors like Asoka, Vikramaditya (Chandragupta II of Gupta dynasty) or Akbar, she was at best a collection of clans, tribes and communities held together by sheer force of central military organizations. Whenever the central forces slackened, she fell apart into units, which developed local languages, customs and cultures, tending to develop into separate states and nations.

India consists of communities (we may avoid calling them nations) speaking 12 major languages, each having separate literature and large number of dialects, but the provinces have not been formed according to linguistic basis. The British have left us a centralized administrative machinery controlling defence, communications and foreign policy, and partly economic policy. English, a foreign language, is the medium of expression in the centre as well as in the provinces. The people are clamouring for reorganization into linguistic provinces, using its own vernacular, and the Centre vaguely talking of replacing English by Hindusthani.

India has therefore the choice of

(1) becoming a great Uni-National State like the U.S.A. or France, or Great Britain,

(2) becoming a Multi-National State like the U.S.S.R.

(3) falling asunder into a number of different sovereign states like the states of Latin America,

(4) becoming something quite different from any of the above patterns.

Everybody will admit that of the first three clear cut patterns, (3) is the worst, but if the present centrifugal tendencies are not intelligently handled, and provincial feeling allowed to gain the upper hand, we may gradually drift to the position of Latin American States which will be worse than throwing off the British yoke.*

* It will be difficult to admit that China proper has one language. China has one set of highly developed symbolisms, common to all China, which expresses ideas just as languages do, but according to competent scholars, she has as many dialects, mutually unintelligible, as the number of days in the year. But China has evolved within recent years the Mandarin as a common phonetic language using alphabets.

* "Latin America" denotes the large number of American States beginning from Mexico in the north to Argentina in the south (altogether 18 in number). They all speak Spanish with the exception of Brazil which speaks Portuguese which is very similar to Spanish. All Spanish American countries started as colonies of Spain after Columbus' discovery of America, but after the Napoleonic wars, they all rebelled against the mother country under Morelos in Mexico, and Simon Bolivar and St. Martin in South America and achieved independence. It was the intention of Simon Bolivar and most other leaders of the Independence Movement that all the Spanish colonies should form one country, as the North American British Colonies had done, but this could not be achieved on account of local patriotism and a number of other causes. Latin American States have remained divided as before, and though taken together, they all speak Spanish and are more numerous than the U. S. A. and most of them are preys to recurrent civil wars, and wars amongst themselves. There are vast natural resources in most of the countries, but they have hardly been exploited, except by foreign exploiters. The standard of living except in one or two countries, has remained very low, almost as low as in India or China.

The Unifying Principle

Has India to go so far as the Russian pattern? We do not think so, for while to the majority of satellite nations and tribes of Russia, the Great Russians appeared with a bad record as cruel conquerors and oppressive rulers, such is not the case with the different people and communities of India. All elements of the population included in the territories of the Indian Dominion enjoy the same status, take pride in the common designation "Indian", and cherish the long traditions of history as a common heritage. Of the 12 major languages which need be considered 8 are derived from Sanskrit, and 4 are Dravidian, and the basic alphabetic system is the same in both, though symbols are different. These languages have developed considerable literature of classical type, but are almost wholly lacking in vocabulary of modern thoughts in science, politics and philosophy.

But can we proceed with the present material as far as the United States of America, which has welded vast numbers of immigrants of all stocks, speaking different languages and coming from all parts of Europe into a homogeneous nation in course of a hundred and fifty years? We are not so fortunate as the U.S.A. which had one dominant group, the Anglo-Saxons, and the immigrants and other aliens were scattered and had no political cohesion. Further, the American educationists had been wise enough to devise a wonderful school system which enables the children of immigrants to become good Americans all speaking English in course of a single generation. The political wisdom of her leaders has prevented all fissiparous tendencies on the part of the component states.*

It is obvious that in this problem of fusing all people of India into one state and one nation, India on account of the absence of a dominant group and a dominant language, is not so favourably placed as the United States of America, which is now a uni-national state.

Necessity of a Common Language

It is therefore prudent to steer a middle course between the U.S.A. and the U.S.S.R. The ideal should be that India is to be moulded into as near an approximation to One Nation and One State but without violence to provincial feeling. We must therefore have one language which will not only take the place of English for central use and interprovincial contact, but should be taught as a compulsory second language in schools in all provinces of India, side by side with the language or languages of the province. As long as we cannot do that we must retain English.

How to Form a Common Language

There is nothing new in this proposal. But no effective steps, except some overzealous ones, are being taken to give effect to this idea. It is not realized that the Hindi language, which is recommended to be the common language of India, is yet very much undeveloped, even compared to some provincial languages of India, has not got sufficient literature and has not got enough vocabulary to satisfy all demands, and express higher thoughts. But as it is the most widely understood language, and has the best chance of being accepted as substitute for English in our all-India political life, attempts should be made to develop it on proper lines. There is nothing Utopian in the controlled development of a language, for a language like a living being has its period of birth, adolescence and growth, and we have an example how these stages can actually be controlled from a national point of view in the case of the French language, which has a unique position amongst the world languages for its clarity. There was a time when France was divided into a number of provinces, which spoke different dialects, Bourguignon, Franc-Comptois, Lorraine, Champenois, Picard, Walloon, Normand, Poitevin, Angevin, Francien, Provencal, Savoyard to name a few. Despite their common origin, these dialects differed so much in pronunciation and vocabulary that Roger Bacon, an English friar, travelling in France in 1260, found that Frenchmen from one part of France did not understand Frenchmen from other parts, and Frenchmen used Latin in preference while talking to each other.

When after the Hundred Year's War with the English, the movement for a centralized state gained ground, one of the dialects, Francien, which was spoken in Paris began to be used for official purposes and considerable literature began to grow, but the decisive step in the formation and fusion of the French languages and dialects was taken

* The greatest crisis in the history of U. S. A. was the civil war of 1856-1860 between the North and the South, on the question of the system of Negro slavery. The eleven states of the South voted to pass out of the Union, when the President-elect Abraham Lincoln took an uncompromising attitude on the question of slavery. But to the challenge of the Southern States President Lincoln boldly replied, "We shall have rather hundred years of civil war than allow a single state to pass out of the Union". Actually five years of civil war were needed to defeat the rebel confederate States, and the Union was saved. But for the heroic stand taken by Lincoln, the division of U. S. A. would not have stopped with the Southern States, and probably the U. S. A. would have split up into a dozen of sovereign states like Latin America. Such occurrences are not improbable in the future history of the Indian Union.

by Cardinal Richelieu, who founded the French Academy in 1635, and charged them with the task of framing a dictionary for the French language. The *Dictionaire General de l'Academie Francaise* chooses and determines the exact meaning and pronunciation of words. On account of such concerted efforts, the French language has become the language of all France, displacing all dialects except the Provencal, and has gained celebrity for its clarity and incorruptibility of syntax, and is therefore generally used for international purpose.

At the present time, most of the Indian vernacular, Hindi included, are lacking in vocabulary expressing higher thoughts in science and technology, law, politics, economics, and even philosophy. Even when two different provincial languages draw from Sanskrit for expressing higher thought, they very often use different words to express the same thought. Thus the English word "Revolution" is rendered in Hindi by *Kranti*, but in Bengali by *Viplava*. The word for 'Light' is rendered by *Prakash* and *Aloka* respectively in Hindi and Bengali and instances can be multiplied. Here is enough work for an Academy of Indian Languages which may, like the French Academy, be entrusted with the task of choosing and defining words for language of higher thought for all the provincial languages and dialects of India, and framing a dictionary for all-India use. This will bring all the provincial languages closer together, and make at least the language of higher thought for all people of India very nearly identical thus leading to the fusion of the principal sanskritic languages of India. Otherwise the imposition of the Hindi language in its present undeveloped stage upon the non-Hindi speaking population might meet with opposition and lead to frustration.

THE DRAVIDIAN THEORY

N. M. CHAUDHURI

CALCUTTA

A PRESS Report from New Delhi dated July 16, 1947, stated "Mahatma Gandhi in his post-prayer speech referred to the movement for Dravidistan and said that it was a myth to consider that those living in the south of the Vindhya Range were non-Aryans and in the north Aryans. Whatever they might have been at one time, they were so intermixed that they were one people from Kashmir to the Cape Comorin." Mahatma Gandhi advised the people to forget it even if it were true because different ethnic elements had intermingled to form the present composite Indian people.

An attempt is made here to trace the history of the Dravidian theory and examine the data of distinguished anthropologists, to find out the truth about the Dravidian question. Though there has been a little change recently in the attitude of some of the anthropologists to the Dravidian question, this attitude is unsatisfactory, and old notions persist.

Ethnological Aspect

The Dravidian question has two aspects, linguistic and ethnological. The ethnological aspect will be examined here. In its origin the Dravidian theory was a linguistic theory, but it developed into a full-fledged ethnological theory which met with world-wide acceptance. The theory was first enunciated by Bishop Caldwell in his famous work entitled *Comparative Philology of the Dravidian or South Indian languages*" published in 1856. It was he who used the word 'Dravidian' to indicate the South Indian languages and later to indicate South Indian people. Sir George Grierson pointed out long after Caldwell's theory had been accepted in Europe that the name 'Dravidian' applied to the principal languages of South India was purely conventional.

> "It is derived from Sanskrit *Dravida* a word which is, again, derived from an older Sanskrit *Dramila* or *Damila* and is identical with the name of Tamil. The name Dravidian is, accordingly, identical with Tamulian, which name has been formerly used by European writers as a common designation of the languages in question. . . . In India Dravida has been used in more than one sense. Thus the so-called five Dravidas are Telegu, Kanarese, Marathi, Gujarati and Tamil. In Europe, on the other hand, Dravidian has long been the denomination of the whole family of languages to which Bishop Caldwell applied it in his *Comparative Grammar*, and there is no reason for abandoning the name which the founder of the Dravidian Philology applied to the group of speeches."

The credit for creating a Dravidian race must go to the learned Bishop, and Grierson himself speaks of the Dravidian race forming the bulk of the population of South India. Caldwell's book illustrates a very instructive process of researches in comparative philology leading to the creation of a new racial type. On the use of the common term, Caldwell admits that it corresponds to Tamil and its use is restricted to

the Tamils (*Com. Philo.* 2nd Ed pp. 5, 7). He admits that Tamil and Telegu grammarians do not use a common term to designate all the South Indian languages, (*ibid.* p. 8) and incorrectly assumes that the Sanskrit writers used Dravida for South Indian peoples (*ibid.* p. 5) notwithstanding the *Manu Samhita* list (*Manu Sam.* X 43, 44) and the references in the Mahabharata with which he shows his familiarity. So the term restricted in its use to the Tamil speaking people is applied to cover people speaking Tamil, Telegu, Canarese, Malayali, Tulu, Kodagu etc.

DRAVIDIAN RACE

Thus arose imperceptibly the conception of the Dravidian race from the conception of the Dravidian family of languages. It may be stated here that Caldwell admits that these languages are not merely provincial dialects of the same language, that Tamil and Telegu are farthest apart (*ibid.* p. 42) and that he has no answer to the question which of these languages or dialects should be considered the family of which the others are members (*ibid.* pp. 80f). He says next,

"There is no proof of Dravidian, such as we have it now, having originated before Kumarila's time (7th century A.D.) and its earliest cultivators appear to have been Jainas" (*ibid.*, p. 122). He thinks, however, that Dravidian is independent of Sanskrit and Sanskrit has borrowed from Dravidian (*ibid.*, pp. 45, 47). He also thinks that "there is remote original affinity between Indo-European languages and Dravidian languages for which the latter may be given a place in the Indo-European group". (*ibid.* p. 46).

About the Dravidian race, Caldwell's view is that it was distinct from the Aryan race. The Dravidians were expelled from northern India by pre-Aryan Scythians not to be identified with the Kols, Santals etc. The Dravidians were themselves Scythians but they belonged to a group which had entered India earlier. The later Scythians but not the earlier group were subdued by the Aryans and incorporated into the Aryan society as Sudras (*ibid.* pp. 108, 109). According to this theory there should be racial affinity between the early Scythians or Dravidians and the later Scythians who became Sudras. But Caldwell is a believer in the independence and integrity of the Dravidians and he is at great pains to prove that the Scytho-Dravidians were altogether so superior a people as to form a distinct race from the "secondary Scythians" or Scytho-Aryans (*ibid.* p. 109, Intro.). As regards the relations between the Dravidians and the Aryans he thinks that they were always peaceful and friendly (*ibid.* p. 108). Dr Muir says, "Dr Caldwell is persuaded that it was not by the Aryans that the Dravidians were expelled from northern India and that, as no reference occurs either in Sanskrit or in Dravidian tradition to any hostilities between the two races, their primitive relations could never have been otherwise than amicable" (*Sanskrit Texts II*/486-87).

IMMIGRATION OF THE DRAVIDIANS

Thus, according to Caldwell, a body of immigrants of Scythian stock entered India through Baluchistan before the Aryans came, followed by another body of immigrants of the same stock also before the Aryans came. Caldwell would give the name Dravidian to the first body and deprive the second group of the name. He does not explain his reasons for it. It has been stated above that in Caldwell's opinion the speech of the Dravidian group shows remote original affinity with Indo-European. About the physical type of the Dravidians his view is that the type is the same as that of the Aryan (*Com. Phil.* p. 558). It is Caucasian or identical with the Aryan (*ibid.* p. 560). But in spite of linguistic affinity with Indo-European, Aryan physical type and friendly relations with the primitive Aryans the Dravidian languages were, according to Caldwell, quite independent of Sanskrit and the Dravidian race was nothing but Dravidian. "The high caste Dravidians claim to be purest representative of the type. Their institutions and manners have been Aryanized but it is pure Dravidian blood which flows in their veins". (*ibid.* p. 562).

POLITICAL LIGHT

How linguistic researches, unaided by ethnological investigations, helped Bishop Caldwell to come to definite conclusions about the independence and integrity of the Dravidian race and purity of Dravidian blood may appear puzzling. In his *Ethnology of India* Sir George Campbell says,

"I draw no wide ethnological line between the northern and southern countries of India, not recognising the separate Dravidian classification of the latter as properly ethnological . . . . A change takes place where passing southward we exchange the Maratta for Telegu or Canarese. But looking at the people we see no radical change of features. . . I have no doubt that the southern society in its structure its manners and its laws and institutions is an Aryan society" (p. 15).

Commenting on the above Dr Caldwell writes,

"His impression of the similarity of the physical type of the higher castes among the southern Dravidians to that of the Aryans of northern India is as strong as mine while the reason for the similarity he assigns is different."

Obviously Dr Caldwell's reason is outside the purview of ethnology.

An instructive passage occurs in the controversy between Dr Caldwell and Mr Gover, author of *Folk Songs of Southern India* who held that the Dravidians were Aryans. Dr Caldwell writes, "He (Mr Gover)

considers it of great moral and political importance to prove that the Dravidians are Aryans and not a Scythian race. The Scythian theory he says, 'shuts up the door of sympathy and fellow feeling between the Dravidian peoples and their English conquerors". (*ibid.* p. 535). Evidently Mr Gover thought that the recognition of the Dravidians as Aryan would make matters smooth for the English conquerors. This hint was lost on the learned Bishop who probably thought that to prove that the South Indians were racially different from the North Indians might prove more advantageous to the English conquerors in the long run.

"Dravidian" Type

Let us now turn to examine the Dravidian type which, in fulfilment of the desire of Dr Caldwell, has become a "settled fact" with anthropologists.

The Dravidian type looms large in Sir Herbert Risley's *Ethnographic Survey*. He gives us the Scytho-Dravidian type in Western India, the Aryo-Dravidian type in the United Provinces, the Mongolo-Dravidian type in Bengal and the Dravidian type in South India. The Dravidian type is defined thus by Risley: "The Dravidian type extending from Ceylon to the valley of the Ganges, and pervading the whole of Madras, Hyderabad, the Central Province most of Central India and Chota Nagpur . . . . probably the original type of population of India, now modified to a varying extent by the admixture of Aryan, Scythian and Mongoloid elements. In type specimens the stature is short or below mean; the complexion very dark, hair plentiful with an occasional tendency to curl; eyes dark, head long; nose very broad, sometimes depressed at the root, but not so as to make the face appear flat". (*The People of India*, 1908). This characterization applies however to those only of the type specimens that have been called Australoid-Veddaic. The specimens of Risley's Dravidian type are drawn from Chingleput, Bellary, Tinnevelly; Coimbatore, the Annamalai hills, Madras city, from Travancore, Malabar, the Nilgiri hills, from Mysore and Coorg, from Mewar in Rajputana, from Chota Nagpur, Santal Pargana and Western Bengal. The cephalic index of the selected specimens varies from 71·7 of the Badaga (Canarese) of the Nilgiri hills (maximum 77·5, minimum 66·1) to 77·0 of the Desatha Brahmans of Bellary (maximum 83·3, minimum 71·0); the maximum rises to 80·0 in the case of Tamil Brahman of Madras city, 85·4 among Shanans of Tinnevelly, 86·4 in the case of Nayar and 90·4 in the case of Kannadiyan (Canarese) of Chingleput). The nasal index varies from 69·1 of the Lambadi of Mysore to 95·9 of the Asur of Lohardaga (the maximum rises to 108·6 among Paniyans of Malabar and 115·4 in the case of the Kadia of the Annamalai hills). The stature varies from 1701 of the Shanan Nattat of Tinnevelley to 1584 of the Chero of Lohardaga. A glance at the variations of the cephalic and nasal indices and stature will show that we have to deal not with one but different types.

Comparative Data

Risley's classification and nomenclature for South India as well as for his other racial zones have been modified. The Dravidian type of South India is especially represented according to Giuffrida-Ruggeri "by the tribes which we place together in the following Summary VII according to the data of the Census of India (from *First Outlines of a Systematic Anthropology*. English translation by H. C. Chakladar).

SUMMARY VII

Typical Tribes of *Homo Indo-Africanus Dravidicus*

	Individuals	Stature	Cephalic Index	Nasal Index
Kota (Nilgiris) ..	25	162·9	74·9	77·2
Badaga (Canarese) ..	40	164·1	71·1	75·6
Kuruba (Mysore) ..	50	163·6	77·3	73·5

In Table IX, he gives the characteristics of the type abstracted from the above: Stature 1629-1636; Cephalic Index 71·7-77·3; N.I. 73·5-77·2. It may be pointed out that at least two of the tribes selected as type specimens, namely the Badagas and the Kurubas are very mixed.

Haddon characterises the Dravidian type as follows: "Hair plentiful; wavy with an occasional tendency to curl; brownish-black skin; medium stature 1·634m; dolichocephalic (C. I. 73-76); typically mesorrhine (N.I. less than 77). Dravidian is a general term for the main population of the Deccan". (*Races of Man*, p. 21). On p. 109 of the same book we have the following; "The general characteristics of the Dravidians or Dravida are given on page 21; as a rule there is little or no hair on the face or limbs. Apart from the language, there is a general culture which is characteristic of the peoples and after the elimination of the pre-Dravidians a racial type emerges with finer features than those of the aborigenes and the conclusion seems evident that this was due to an immigrant people who reached India before 2000 B.C. . . . Apart from the dark colour of the skin there are points of resemblance between the Dravidian and Mediterranean people which point to an ancient connection between the two, perhaps to a common origin."

"Speaking generally, certain groups in and the higher castes of South India exhibit what are taken to be the original Dravidian characters." *ibid*, p. 109).

It may be said that this seems to be a rather unconvincing manner of defining a racial type.

Now, the standard cephalic and nasal indices and stature of the Dravidian type according to the two eminent anthropologists are as follows ;

	C. I.	N. I.	Stature
Giuffrida-Ruggeri	71·7-77·	73·5-77	1629-34
Haddon	73-76	77	1634

The application of the test of the Nasal Index will remove all the specimens from Risley's list after the first sixteen while the standard of the Cephalic Index applies to all the specimens.

We give below a comparative table with data drawn from Thurston in 4 groups comprising Tamil, Malayali, Telegu and Canarese-speaking tribes or castes to examine how far the above test hold good.

TABLE I

	Caste or tribe	Number of individuals	Cephalic Index	Nasal Index	Stature	C. I. 80 & over 80
Tamil	Kammalan	40	75	77·3	1597	5
	Palli	40	73	77·9	1625	1
	Pattar Brahman	25	74·5	76·5	1643	2
	Paraiyan	40	73·6	80	1621	0
	Vellala	40	74·1	73·1	1624	
Malayali	Nayar	40	74·1	71·1	1652	1
	Tiyan	40	73	74·2	1642	1
	Cheruman	28	73·9	78	1575	1
	Mukkuvan	40	75·1	81	1631	0
	Pulayan	24	76·3	79·3	1531	0
Telegu	Kapu	49	80	72·8	1645	16
	Komati, Adoni	25	77·9	77·8	1619	16
	Odde	40	77·3	77·5	1654	10
	Golla	60	77·5	74·1	1638	12
	Mala	50	71·1	76·2	1639	6
Canarese	Vakkaliga, Mysore	50	81·7	73	1672	27
	Boya	50	77·9	75	1608	14
	Mandya Brahman	50	80·2	73	1657	31
	Hebbar Brahman	50	80·1	70·1	1652	21
	Holeya	50	79·1	75·1	1628	20

Analysis of Data

The application of Haddon's data' in respect of C. I. would exclude the 4th group (Canarese-speaking) entirely as well as the 3rd group (Telegu-speaking) from the Dravidian type. The 3rd group is mesocephalic but the percentage of cases in which the cephalic index is 80 and over is remarkably high. The 2nd (Malayali speaking) and 1st (Tamil speaking) groups are dolichocephalic but the percentage of cases in which the C. I. is 80 and over is larger in the first than in the second group. In three out of five castes in the 4th group the nasal index is lower than the figure given by Giuffrida-Ruggeri ; it is lower in one caste in each of the first three groups. Two castes, one in the 2nd and one in the 4th group, is leptorrhine, and in four castes in the 1st, three castes in the 2nd and two castes in the 3rd group the nasal index is higher than 77. In regard to stature four castes in the 1st group, two in the 2nd, one in the 3rd and three in the 4th group fall below Haddon's standard. We find that of 20 specimens belonging to 4 language groups there are only two which satisfy the requirements of the so-called "Dravidian" type laid down by eminent authorities like Haddon and Giuffrida-Ruggeri, *viz*,

	C. I.	N. I.	Stature
Pattar Brahman (Tamil)	74·5	76·5	1643
Tiyan (Malayali)	73	74·2	1642

We may also consider the following comparative table consisting of data drawn from Dr B. S. Guha's in Census Report 1931, Vol. I, Part 3.

TABLE II

	C. I.	N. I.	Stature
I. Tamil Brahman	81·77	74·07	1685
II. Canarese Brahman	91·30	62·96	1618
III. Telegu Brahman	76·19	73·08	1621
IV. Nambudri Brahman	71·78	60·71	1676

None of the four types fully satisfies the requirements in regard to the cephalic and nasal indices and stature.

All that we may say from the above analysis is that dolichocephaly and mesorrhiny are general characteristics of the Tamil and Malayali groups, mesocephaly with a high percentage of brachycephaly (nearly 32 in the case of the Kapus) and mesorrhiny of the Telegu group and brachycephaly and mesorrhiny of the Canarese group. Mesorrhiny is thus a common characteristic of all the four groups but leptorrhiny characterises, as we find from the two tables, the two higher Malabar castes, the Nambudri Brahman and the Nayar as well as the Canarese Brahman (Table II). It has been suggested that the common characteristic of mesorrhiny is due to racial admixture, "crossing with a dark-skinned

...oad-nosed race of short stature". "Whether the ...ngle tribes are, as I believe, the microscopic ...mnant of a pre-Drávidian people, or, as some hold, ... Dravidians driven by a conquering race to the ...clusion of jungles, it is to the lasting influence of ...me such broad-nosed ancestor that the high nasal ...dex of many of the inhabitants of Southern India ...ust, it seems to me, be attributed". (Thurston, ...stes and Tribes etc. I lv).

The above makes it clear that Risley's concep...n of the Dravidian type is different from the con...ption of Haddon and G. Ruggeri. (It may be ...oted that Giuffrida-Ruggeri affiliates the Dravidian ...pe to the Ethiopians with the exception of the ...malis and Gallas). Risley's theory has been modi...d and a distinction has been drawn between clearly ...tyrrhine types of short stature and dark skin and ...sorrhine types of medium stature, the former being ...lled pre-Dravidian and the latter Dravidian. After ...reful analysis and comparison we find that there ... such wide variations in the cephalic indices, ...ferences between the maxima and minima of nasal ...dices and in stature that the conclusion is forced ...n us that the so-called Dravidian type as a uniform, ...ble racial type is non-existent. If there is no ...cial type with clearly identifiable somatic traits ...ich may be distinguished as Dravidian, probably ...ly extraneous considerations or imperfect ideas ...uld have brought into being a Dravidian race.

Origin of the Dravidian Type

We may leave the controversy regarding the ...avidian type at this stage and refer to the two ...ories which are current regarding the origin of ... Drávidian type. One of the theories is that of ...aldwell who held that the Dravidians came from ...ntral Asia through Baluchistan. Two evidences, ... supporting the other, have been cited in support ... the theory. One evidence is the presence of ...vidian speaking Brahuis in Baluchistan. The ...r is the discovery of long-headed skulls at ...henjo Daro, Nal and Makran, which have been ...ed as Dravidian or Mediterranean, speaking ...vidian. Though there is no known formula for ...taining the speech of persons from the study of ...a still some anthropologists have attributed the ...vidian speech to the long headed Mohenjo Daro ... because of its particular head form. About the ...d evidence it may be said that until and unless ...itative decipherment of the Indus script proves ...d doubt that the Indus language can be affiliat... the South Indian languages, the theory that the ... people were of Dravidian speech should be ...d.

About the first evidence it may be said that the so-called puzzling Brahui question does not prove the contention of Caldwell nor does it help the case of those who would prove that the authors of the Indus Civilization were Dravidians because the Brahuis are Dravidians or of Dravidian speech. According to Caldwell, the Dravidian race, though resident in India from a long period prior to the commencement of history, originated in Central Asia and "leaving a colony in Baluchistan they entered India by the way of the Indus" (*Com. Philo.*, p. 70). This so-called Dravidian colony in Baluchistan is represented by the Brahuis. This Brahui question is another instance of the creation of a race from linguistic theory. The Brahui language has been generally described as Dravidian and Caldwell believes, as will appear from his statement above, that the speakers of the Brahui language are also Dravidian. Dr Hutton and others have built up a comfortable theory taking their cue from Caldwell and Grierson. Dr Hutton says, "The presence of the Brahui . . . . points very suggestively to speakers of Dravidian languages as the inhabitants of Mohenjo Daro" (*C. R.* 1931, vol. 1, Part I, p. 455). It has now come to be doubted whether the language of the very mixed Brahui tribes can be correctly affiliated to the Dravidian languages though Grierson has classed it as Dravidian. Dr Caldwell, whom Grierson follows, explains that the theory he advocated was not that Brahui was a Dravidian language, "but it contained a Dravidian element which was probably derived from the remnant of some ancient Dravidian race incorporated with the Brahui". (*Com. Philo.*, p. 519). The word Brahui does not appear to have an ethnological sense, it signifies a coalition for political purposes of the tribes of the hilly country. The word may have come from the term Barohi, which in Sind is generally used for the hilly country of Kalat. The language of the Brahuis is known as Kurd-gali. (*Baluchistan Gaz.*, vol. VI, p. 49; *cf.* Jadgali, the language of the Jats.) The Brahui tribes are generally believed to have come where they are now found much later than the Balochs. There is a very strong Jat element among the Brahui tribes, particularly in Shalawan and in Kej-Makran. In the Khash district there are certain Brahui tribes known as Brahoki. These are pastoral tribes. The Brahui tribes claim that they have come from Seistan. It has been suggested that they are probably a remnant of the Ghaz tribes who overflowed into Kirman and Afghanistan after they were pushed out of Central Asia and that "most of the Brahui tribes are of other well known ancient origins such as Mamassein, who are Lurs, the Mirwani who claim descent from Arab ancestors who came originally from Oman or they consist of a variety of races drawn together and forming tribes by the obligations entailed by blood feud". The examples are

the Menegals of Jhalawan who are of Persian, Afghan and Jat origin, the Mardoi clan who are Bulfat Jadgal etc. (G. P. Tate, *Seistan* m, p. 368). Of the Brahui tribes of Sarawan the Raisani are connected with the Spini Tarim Afghans, the Dehwars are Tajiks, the Lahri belong to the Dombki stock of Baloch origin, the Sangav are of Jat origin, the Gurds are an offshoot of the Persian Kurds (*Baluchistan Gaz.*, vol. VI, pp. 49f.).

It will appear thus that there is neither any Brahui race nor any Brahui language properly so called and the Brahui question, properly investigated, would liquidate rather than confirm the Dravidian theory of Bishop Caldwell and his followers.

Alternative Theory of Origin

To come to the second theory of the origin of the Dravidians, scholars in favour of this theory think that the Dravidians did not come from outside, they were indigenous in India. They were Proto-Australoids in origin and developed the Dravidian character by intermingling with foreign elements and by a process of natural selection. This theory leaves the important question of the identity of the elements with which the Proto-Australoids intermingled undecided. This question has been answered by Emile Schmidt who holds that North Indians intermingled with the Proto-Australoids of South India and produced the people called Dravidian. But it may be pointed out that hybridization has not produced a people with stable and uniform somatic characteristics which would justify the use of the term Dravidian with an ethnological sense.

To come to the conclusion. From the anthropometric measurements of the Canarese, Tamil, Telegu and Malayali speaking peoples and people in other parts of India, Dr Guha has worked out co-efficients of racial likeness. The results obtained by him confirm what we have found out from the examination of Bishop Caldwell's theory and analysis of anthropometric data for fixing the Dravidian type, namely that the South Indians like the North Indians are mixed and interrelated. According to Dr. Guha's findings the Tamil castes show relationship with the Maratha and Kannada castes and others including Bengali Brahmins, Kayasthas etc. and the people of the Central India and Orissa. The Kannadas show relationship with the Gujratis, Bengalis, Marathas (Nagar Brahmans, Chitpavanas, Bania Jainas, Bengali Pods) etc. The Telegus show relationship with the peoples of Central India, the U. P., and Oriya Brahmans, Rajput, Malve Brahmans, Bengali Pods, Chitpavanas etc. The Malayalis show relationship with the U. P. Brahmans, C. I. castes and others (For the co-efficients of racial likeness on which these relationships are based see *C. R.* 1931, vol. I part III, lix).

The name Dravidian has been discarded by some anthropologists because it is a linguistic name and they prefer the term Mediterranean. The high percentage of brachycephaly and mesaticephaly among the Canarese, Tamil, Tulu and Kodagu speaking castes clearly prove that the South Indians do not belong to one stock, as their classification as Mediterranean would indicate. Apart from this fact, there is another important consideration. The long-headed peoples of North India, more particularly of North-western India, who were formerly classed as Indo-Aryan and Indo-Afghan are held by Dr Guha to be mainly of Mediterranean stock mixed with the Oriental, (a later Mediterranean strain) and other strains. This Mediterranean element in India is held to be as old as the Indus civilization and according to Dr Guha, it "forms to-day a dominant element in the population of northern India and an important constituent of the upper section of the people in the rest of the country" including South India. The particular Mediterranean strain present in India from the Indus age and prevailing in N. and S. India has been described as "Europoid" by Dr Guha, Eickstedt and others. If the Aryan question is left out of consideration, we find that the North Indian and South Indian long heads are both pre-Aryan. If this fact is taken into account, we find that the points of similarity between the North Indians and South Indians are so many according to the anthropologists that Aryanity can hardly be conceded to the people to the north of the Vindhyas and denied to the people south of the Vindhyas. The fact, however, seems to be that the Aryan race whatever its type, long-headed or round-headed (see Were the Vedic Aryans Proto-Nordics? in SCIENCE AND CULTURE August, 1946, has been completely submerged. It may be noted here that brachycephaly among the Canarese, Tulu, Kodagu and Tamil castes has been attributed to Alpine immigrants from the Pamirs. Culturally, there is no difference between the two groups. This is admitted by the father of the Dravidian theory and others. Linguistically, if Caldwell's theory that the Dravidian languages are of the Indo-European family, be accepted, the difference between the two groups is reduced to nil.

RECLAIMING THE INDIAN DESERT

MANECK B. PITHAWALLA

KARACHI

Introduction

RECENTLY a news item appeared in the press that the Sind-Rajputana desert was spreading northward and eastward and that too at the rate of half a mile a year! Such statements, in the present condition of our country, are misleading and it is the purpose of this article to take stock of the desert conditions and to help the authorities with a programme of resuscitation and revival of the lost land. For, no part of the earth permanently remains in the same condition.

That the Thar desert in the north-west of India is not a real desert, like the Gobi or the Sahara, many explorers have averred. Major Glennie, who toured the area in 1930-31, has given a picture of it and suggested some of its peculiarities in a paper in the *Survey of India, Geodetic Report*, vol. 7. Sir Aurel Stein, one of the greatest Asian explorers, whose loss we mourn today, surveyed a number of ancient sites along the lost Saraswati river and pointed out the real causes of the so-called desiccation within the Hakra-Ghaggar valley in his valuable contribution on the subject, published in the *Geographical Journal*, April 1942. Dr. Cotter of the Geological Survey of India, who spent a season during 1918-19 in some of the worst parts of the Sind desert, has stated that although it is customary to speak of it as a desert, it is by no means so devoid of vegetation as even Baluchistan. And then he speaks of a vigorous flora growing in this desert in certain localities. Stein has agreed that some of the desert areas in Asia are not nature-made but man-made. The mischief, to a great extent, lies at the door of man, who, having disturbed nature in these regions, has upset her plan and is now reaping the fruits of it. Fresh water flowed through some of the driest channels lying on the earth's surface, when nature was undisturbed by man and when forests were not mercilessly cut down and excessive grazing in the upper reaches of the rivers was actually prohibited by law. Much mischief within our region has also been made by those greedy peoples, who have damaged the foothills of the Himalayas in the Ambala district and its neighbourhood, as a result of which the river channels downstream have suffered, and excellent cultivable lands are lying barren and deserted.

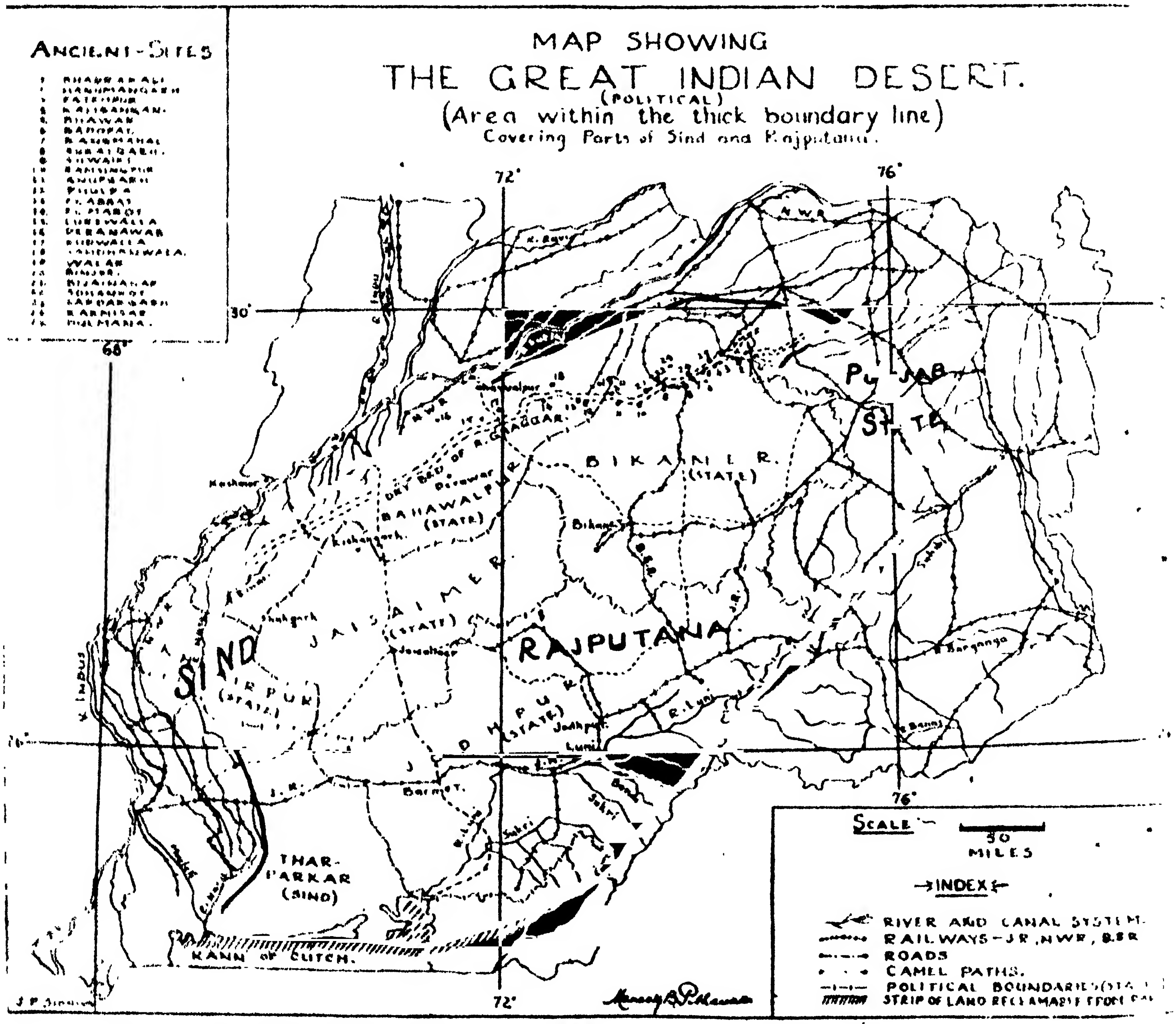
Historical Review of the Region

Towards the north of this desert tract, actually near its border in the Bhawalpur and Bikaner States territories, lies the now-deserted dry bed of the Ghaggar, bestrewn with ancient archaeological sites, more than twenty of which have been pointed out in the map on next page. After visiting them one by one, Sir Aurel Stein has remarked: "How great is the contrast between the very scanty volume of water brought down by the Ghaggar and the width of its dry bed within the Bikaner territory; over more than 100 miles, it is no where less than 2 miles and in places 4 miles or more." Seen from the air, this part of the desert discloses a wonderful pattern of a river system, parts of which can be, the present writer believes, revived today with modern means and up-to-date engineering. Stein was convinced that the mighty Ghaggar once carried the combined waters of all the Ambala streams, and of one or two branches of the Sutlej river and still lower down the Hakra was fed by the flood waters of the Sutlej in the Bahawalpur State and of the Indus through the Aror gorge near Rohri. From a thorough examination of the numerous mounds, the patterns on the pottery and other relics, he surmised that the prehistoric river must have first dried up on the lower side within the Bahawalpur State and later on but gradually got truncated and lost its waters in Bikaner and further towards the hill-side, through which the sacred Saraswati rushed in ancient times. The present Ambala streams are the only relics left of it. Away in the Khairpur State and Eastern Sind, the Ghaggar found in the Wahinda, the Sind portion of it, a continuation of its course through the present Raini and the Eastern Nara canal and fell ultimately into the sea near the Rann of Cutch. Thus it is quite likely that the triple river system must have irrigated some 7,000 sq. miles of the now barren desert land in the north and the west of the Thar. The question now is, can this ancient river system be revived to some extent at least? Can man prevent the desert from marching northwards, if at all such is the case?

The Eastern Nara Parallel

The answer to this can be supplied by quoting the instance of the Eastern Nara canal, now one of the most successful of the Sukkur Barrage perennial canals and watering a large part of the western margins of the Indian desert in the Khairpur, Nawabshah and Thar-Parkar districts. This canal system actually follows the natural course of the old river, which was fed by the river system in the north

in past ages. Being at a lower level than that of the Indus valley on one side and the sand-ridden Thar on the other, it received the flood waters from every side and cut a deep channel, which has been utilized well by the Barrage engineers. In 1842-43, Sir William Baker noticed a flood-mark rising nearly 18 feet! The discharge it used to carry formerly was some 1,50,000 cusecs. Before its conversion into the perennial canal, which it is today, with its intake from the Barrage, it had become a famished stream, very much like the upper Ghaggar of today, broken in places into Dhoroes merely, such as Dhoro Rahmore and Dhoro Hakro, and losing itself into the sands of the Thar Parkar area before it could reac the sea. This old course of the E. Nara was al affected by the Cutch earthquake of 1818, and t upheaval of the Allah Band area made it wester little in its delta part towards the Kori creek. Toda this old instability or inability of the Nara is gon and it is flowing easily and more majestically tha even the Suez Canal, as it is actually 512 miles and commands some 2,140,000 acres of the 'des land with a discharge of more than 13,000 cu at the head. There are altogether nearly 10,000 m of water courses taken from it, old and new. W a wonderful transformation is this with the aid



Map showing the Great Indian Desert, political boundaries, Native States involved, ancient archaeological sites, roads, railways, camel paths, etc.

modern civil engineering and what a blessing this E. Nara Canal is to the rural population of eastern Sind and Khairpur State!

Some kind of revival like this may take place in the Ghaggar valley, if a scheme of national planning is prepared in consultation with the various political powers, among which the whole territory is divided and subdivided at present.

Analysis of the Desert Conditions

The Ghaggar plain has a wonderful geological history of its own. At first it lay within the foredeep, between the advancing Himalayan mountain folds and the old horst of the Gondwanaland, and then a geosyncline occupied by the Tethys sea later. This sea, however, gradually receded, leaving behind a lake and later a number of rapidly flowing streams, as they at times were rejuvenated by the Himalayan uplift. The result was a very large amount of detritus, gravel, sand and silt deposited in it. The varying silt and sand charges stimulated many hydrographical changes, so much so that the whole of the Pleistocene plane of Old Alluvium was well-nigh dissected by newer rivers, which cut their valleys afresh into the alluvium and covered it with fresh riverine deposits. Today wind-blown sand and loess have completed the process of alluviation, so that deep boring made in the Ambala area in 1925-26* showed a remarkable depth of some 1,612 feet of alluvium without touching a stone inside. The core actually contains layers of sand and clay of 40 to 50 feet thickness with occasional bands of gravel. On the whole, this part of the Indo-Gangetic plain is considered to be a good natural reservoir of sweet water, which can be utilized for irrigating the 'desert' fringes by means of some deep borings.

But the most important feature of the Ghaggar plain is the large number of river-beds and ancient channels, now waterless and barren but flanked on both sides by continuous ridges of sand hills, and even protected by a growth of scrub in the riverine belts. The beds show loamy soil, lying between light sand areas on either side and so rich that even a light shower or rain would make it very fertile. Parts of the flood plain called 'kutcha' land once flooded by the river waters, now lie dry and parched and await a fresh supply of water from the higher reaches, as in olden times. This 'desert' again, is not at all rainless. In fact, there is more rainfall here than in some of the worst parts of the Punjab and Sind, as much as 10 to 15 inches of it being derived from the numerous storms passing over this desert belt. Throughout the year, particularly from January to August, several western and eastern depressions cross and recross this zone. Even in the matter of hail-storms we find a frequency of 27 days and 32 days, during the period of 100 years, in the very heart of the desert near Jodhpur and Bikaner respectively. And forst, too, is common during the winter season, so that the important factor of climate is helping and *not* hindering any process of stimulation which may be developed in the reigon.

Northern Limits of the Lost River of the Desert

The Punjab Government had several schemes of dams and weirs to be built across the Punjab rivers, *e.g.*, the Bhakra dam on the Sutlej. Five more weirs were proposed to be constructed at Ruper, Ferozpur, Sulemanke, Islam and Panjnad. It must be an aim of the new government to conserve *all the water* in this river and to arrange, by cooperating with the States, to remodel the Ghaggar-Hakra channel, like the old Nara in eastern Sind, and to supply water for irrigation through powerful branch-canals and distributaries with intakes from each of these dams and weirs in the Punjab. As stated above, irrigation engineers have always taken advantage of old river-courses for their new irrigation canals. So it will be possible to rejuvenate this old river towards the north of the desert and irrigate large parts of the Bikaner, Jaisalmer and Bahawalpur territories as well as the Sutlej and Indus riverines.

That there is enough water in the Sutlej to spare for the desert as well as for Sind goes without saying. Hundreds of thousands of cusecs of water are even now allowed to run to waste into the sea. More and more ramming works and canalization are needed. The newly projected Lower Sind Barrage is another good instance of a project for preserving this precious water for the time being and turning barren lands into smiling fields. A rough calculation of the discharge of water through the present rivers shows that even after *all* the Punjab and the Sind projects are carried out, some 200,000 cusecs of precious water will still continue to run into the sea, while our desert lands are parching and thirsting for water. During the winter season, when the supply is low, hardly 25,000 cusecs would be required both by the Punjab and the Sind irrigation departments for the *Rabi* crops. Much of the *Rabi* cultivation in the Punjab is done on small river and well supplies after a rainfall of about 20 inches for the year. While well irrigation is not possible in Sind, the provision for dry cultivation in some parts of it is a relieving feature.

Side by side with this scheme of new dams, weirs and canals for our rivers, afforestation in the

* *Records, Geological Survey of India*, Vol. LX, Pt. 3, 1927

upper reaches, control of grazing and estimation and utilization of glacial waters from the Himalayan foot-hills are needed. A certain number of trial borings for the perched water in deeper layers in the alluvium should also be undertaken.

Eastern Limits of the Desert

Rejuvenation towards the eastern part of the desert is much easier than towards the northern limits. This part of the desert differs from the numerous Dhoroes and dry river beds of the northern and western parts. It is more or less a rocky plateau along the fringes of the Aravalli mountains, now so greatly denuded and turned into a peneplain of arid waste land, the results of sub-aerial decomposition and re-deposition of rock material, stream wash etc., on the lower levels. The finer debris is removed by the wind agency and spread over many miles of barren country, with scattered outcrops of old crystalline rocks here and there. Occasional storms of rain are the chief source of water even in this area and some wheat is grown in valleys under favourable circumstances. The Luni river system is the most vital part of this side of the desert and it has to be saved, for the greater part of the year, from a loss of its water through terrific floods and from drift sand. Observers have marked a climatic change of slight intensity here. In his geological survey of Rajputana, Dr A. M. Heron has referred to an increase of rainfall in recent years, evidenced by deep *increase of rainfall* in recent years, evidenced by deep trenches and dissections in the hills, by streams deepening their beds and cutting back the higher portion of the alluvium. As we go towards southern Rajputana and northern Gujrat, there is a decided improvement in the rainfall, from 25 to 30 inches having been recorded there. These are all very hopeful signs for revival of the Steppe desert area, falling within the limits of Rajputana.

Geographical Value of the Luni Basin

What is really needed by way of planning here is some well-designed solid training works on the Luni and its numerous tributaries, which carry thousands of cusecs of precious rain water into the sea without notice during the season. It has quite a flashy seasonal flow and its waters turn brackish downstream. In spite of this, nearly half of the agricultural wealth of the Jaipur state, which forms a part of the desert, is due to the presence of the Luni and its tributaries.

The Luni river has its source in the Aravalli range and has a decent catchment area near Pushkar lake. Its total length is nearly 500 miles, its average slope 1 in 1500, depth 8 feet, width 3,800 feet and an approximate basin area 22,000 sq. miles. Its greatest peculiarity is that it tends to increase its width rather than deepen its bed. The flood waters do not get time enough to scour the bed, so that instead of taking its normal course through its own valley, the river spills over the country, and endangers not only the farms and fields but also the very few communication lines, such as the Jodhpur railway, which actually runs parallel to it for some distance. The discharge during the flood of 1944 was nearly 260,000 cusecs and the surface velocity of the water 10 feet per second. Lightning floods are common in the Luni basin and they must be prevented by some means. The flood absorption on the way is very considerable, which is therefore a hopeful feature of the desert for raising dry crops.

To prevent all the good waters draining the east margin of the desert from being wasted into the Rann of Cutch, engineers should construct some terraces and *bunds* across the Luni and its tributaries in the upper reaches, in order that the discharge may be controlled and the waters allowed to flow smoothly and slowly downstream. Contour terracing for raising more wheat crops is recommended. For preventing inroads of sand, green vegetation screens and other solid but permeable barriers have to be constructed along the banks of the rivers.

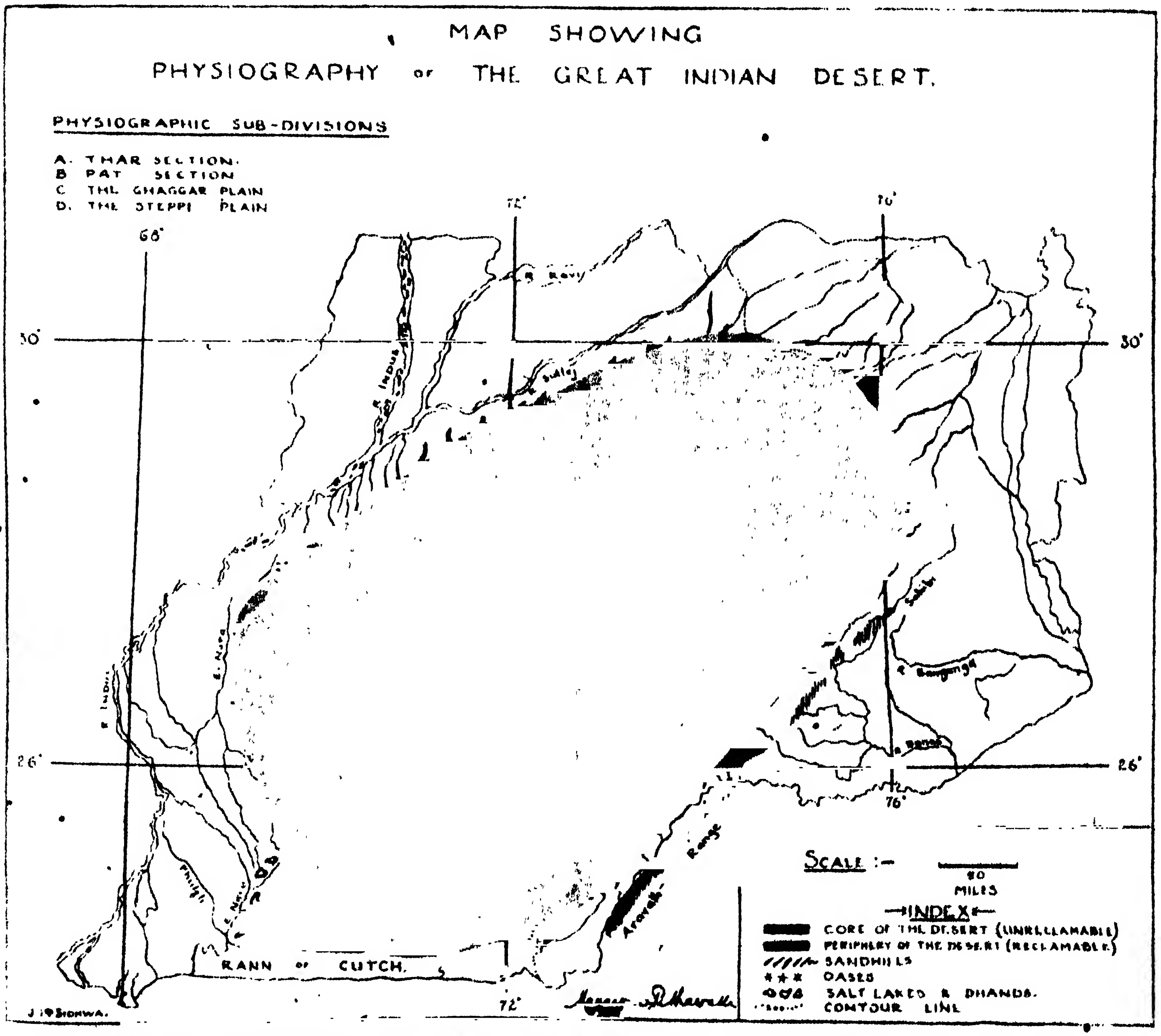
Outside the Luni basin, there is another important feature of the Steppe desert area, *viz.*, the numerous natural reservoirs for water, the *Jhils* as they are called in Rajputana. They cover many square miles, *e.g.*, the Bhatkini *Jhil* in the S. W. of the Jodhpur State, is some 50 sq. miles in area during the monsoon season. When they are dry they yield rich crops of food, such as wheat and gram during the winter season. The chief point about these *Jhils* is that they are the result of inland drainage and soon turn into salt marshes. While reviving the desert, efforts have to be made to prevent this speedy conversion of fresh water lakes into salt marshes by skilful bunding together with a programme of afforestation on their banks, in order to prevent the lakes from emptying quickly.

Lines of Communication

Such a scheme of reviving the desert tracts would be worthless without proper roads and communications and improvement of such few but vital lines of communication as exist in the different parts of the Indian desert. A glance at the map, will show that although there are some old camel and caravan paths, going in different directions, and a couple of railway lines belonging to the Jodhpur and Bikaner States, there are practically no roads, *kutcha*

motorable. Throughout the desert area there are ly two small cuts found, *viz.*, Jaisalmer to Harmar nd Bikaner to Kalayat. With the revival of the Ghaggar and the Luni valleys, there will be an urgent need for two new railway lines along their valleys. Thousand of acres of land and numerous agglomerated villages will thus be catered for and there will be increased prosperity in both the valleys.

of damming a river in higher reaches must have its repercussions downstream and must have its sanction from the governments of the different provinces and states. Any damage done to the hillside or the water courses in the plains must be made good on the basis of cooperation and coordination. If the Central Government cannot interfere with the different provincial or State administrations, they can all come to



Map showing the physiography of the Great Indian Desert, physiographic divisions A. B. C. D.; core of the Desert, Drainage, Dhands, etc.

A Regional Basis of Planning Necessary

It is to be clearly understood that such a scheme of reviving the desert areas by means of renewed irrigation and communication can only be undertaken on a *regional* and not a provincial basis. Any scheme

some mutual understanding as regards a successful programme of planning and a judicious allocation of the waters for their territories. On the north side, the newly-formed province of East Punjab, and the states of Patiala, Nabha, Bikaner and Bahawalpur

will be involved ; while on the east side of the desert, Ajmer-Merwara, Sirohi and Jodhpur States will be affected. Only a wise, long-range and regional policy would be profitable to all of them, inasmuch as the interests of the different peoples inhabiting these territories would be safe-guarded thereby.

Conclusion

So the Sind-Rajputana desert is not a real desert nor can it be said to be expanding on its north and east sides in any way. Its area would, on the contrary, shrink rapidly in these directions, (just as its growth has been arrested so efficiently on its west, in the province of Sind and the Khairpur State, after the opening of the Sukkur Barrage in 1932) if only the aid of scientists and engineers is sought after a thorough geographical survey of the entire area.

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WASTE CINCHONA MATERIALS FOR PRODUCTION OF QUININE

SUDHAMOY MUKHERJEE

BENGAL IMMUNITY RESEARCH LABORATORY, CALCUTTA

THAT India produces less quinine than she needs was painfully evident to all during the past few years when external supplies had been cut off with Japan's entry into the World War II. Before the War, the annual consumption of quinine in this country was 2,10,000 lbs. out of which only 70,000 lbs. were produced locally and the remaining 140,000 lbs. were imported. The sudden stoppage of imports created a gap, which it has not as yet been possible to fill. The potential requirement of quinine is, however, much higher, running over a million pounds every year. It is therefore worth while to consider the means by which the production of quinine can be sufficiently increased in order to meet our requirements. The possible ways by which this object may be achieved are. (*i*) by extending cinchona plantation areas ; (*ii*) by improvements in cultivation method, in the widest sense, leading to increased yields from the same area ; and (*iii*) by recovering the quinine thrown away with the waste cinchona materials.

Extension of Cultivation

Extension of cultivation is the most obvious means of increasing the production of cinchona. At present, almost all the cinchona plantations are owned by the Government (which are mainly in Bengal and Madras and some are in Assam), and from available reports it appears that they have adopted certain expansion schemes, though these are of very limited scope compared with both actual and the potential requirements of the country. To cite an example, it has recently been announced by the Government of Bengal that they have fixed the target of production of quinine at 1,00,000 lbs. a year, which they expect to reach by 1960. Private parties are now being called upon to start cinchona plantations to supplement the production under Government auspices. But cinchona trees need from 7 to 8 years to mature and yield the required quality of bark, and therefore quick returns cannot be expected immediately after taking up the venture. Besides, cinchona needs a special type of soil and climate and our present knowledge is not adequate to predict with certainty the suitability of any particular area for cinchona cultivation. The prospect of a long period of waiting coupled with uncertainty of success is sufficient to scare away many a would-be cinchona planter. The Government had not been, in the past, eager to extend help and protection to private enter-

use in this field. There is a primary need of a thorough scientific study leading to the characterization of the soil and the climatic conditions for successful cultivation of cinchona. Such a preparation can only serve to inspire confidence among planters and lead to healthy expansion of cinchona production.

Improvements in Cultural Methods

The improvements that are needed in the present system of cinchona growing in India are many.* The need for the characterization of soil and climatic factors has been just mentioned. There is great scope for increasing the alkaloid contents and particularly of the quinine contents of bark. This can be achieved by scientific methods of selection and breeding and by controlled propagation of desirable strains and the elimination of undesirable ones. At present, the average Indian bark contains not more than 5 per cent of quinine as against from 8 to 10 per cent in Java. The scientific investigations in cultural methods should also be directed towards improving strains of cinchona so as to produce varieties which will give higher bark yields and will be hardy enough to be grown in the plains.

The above, however, refer to long-range plans and even if they are given effect to now, the results can be achieved after several years, and in some cases decades. But the demand for increasing the production of quinine is urgent and immediate, and calls for immediate steps for relieving the critical situation.

A suggestion was made during the last war for adopting a modified method of cultivation, commonly known as the "Russian method", for quick production of cinchona. The essential part of the method is to plant the cinchona with close spacing and to uproot all or some of them while young, thus yielding a crop of harvest within a short period after planting. The name owes its origin to the belief that in Russia, where conditions are adverse due to frost in the winter, cinchona has been successfully grown by adopting a similar procedure. The seedlings raised in the spring are wintered in green-houses and put out in the open during the next spring. These are uprooted before the advent of next winter. In Indian plantations where green-house is unnecessary, it should be possible to modify and adapt the method suitably so as to yield the optimum results. Some experiments on these lines were also reported to have been undertaken in certain Government Cinchona plantations, and the results are awaited with interest.

* Some of these have been discussed in an article by Dr. P. Basu and the author in the *Indian Journal of Pharmacy*, January-March, 1947.

Need of Cheaper Method of Extraction

The drawback of the above method, however, is that the young plants will yield material relatively poor in alkaloids, and the cost of extraction would consequently be considerably higher. Even if it were possible to peel off the bark of the young plants, this would contain only from 2·0 to 2·5 per cent of total alkaloids and would yield from 1·0 to 1·5 per cent quinine sulphate from 2-year old plants. But in practice it is difficult and uneconomical to separate the bark from such young plants, and the alternative would be, as is done in Russia, to crush the whole plant into powder and to extract the same. The total alkaloid content of the whole plant material would not ordinarily exceed 1·0 per cent. The success of the whole method would therefore depend upon finding an alternative and cheaper method of extraction of the alkaloids from such materials in place of the present method which is based on extraction by organic solvents.

Acid Extraction Process

The acid extraction of cinchona bark has often been tried as an alternative method for the isolation of the alkaloids. Experience has, however, shown that by extraction with dilute acids, not more than 50 per cent of the alkaliods originally present in the bark can ordinarily be isolated. But this drawback can be obviated if the alkaloids in the acid extract can be removed by adsorption on some suitable material so that the regenerated acid can be used again for the extraction of the bark. The adsorbent in its turn can be washed free fram the alkaloid by dissolving out the latter with suitable solvents. A portable plant for the extraction of cinchona, based on the acid extraction *cum* adsorption principle, has recently been developed in the U.S.A. as a result of researches carried out under the auspices of the Engineer Board of Research of U.S. Army. The extraction runs in a continuous cycle, the acid being circulated alternately through the bark and the adsorbent, and the efficiency of extraction is stated to be 90 per cent.

The product obtained by this process is "totaquina", a mixture of all cinchona alkaloids extracted from the bark. It has been claimed that the totaquina prepared in this manner is pure, and the cost, which has been given as $0·0038 for a 10-grain dose, is low compared with that of quinacrine (mepacrine) or even of quinine at pre-war rates.

In America, the problem that they set out to solve was to exploit the scattered and isolated cinchona stands, discovered by laborious searches in the forests of South America. Portability of the plant was therefore a main consideration for them. But in India, where most of the cinchona is now in

the Government plantations situated in fairly compact areas, efficiency and economy of extraction, rather than portability are of utmost importance. A synthetic ion-exchanging resin has been used by the American workers as the adsorbent. But this is not available in this country, and for developing a process on these lines in India, it will be necessary to find out adsorbent materials, possessing the necessary characteristics, and easily available in this country. Researches are also necessary* for working out the details and designs of the plant for working with the types of materials actually to be employed for extraction.

RECOVERY OF ALKALOIDS FROM WASTE MATERIALS

If a cheap process of extraction, as envisaged above can be successfully developed here, it will also open up other possibilities in cinchona production. At present, only the bark of the cinchona tree is collected and the other parts are thrown away. These waste materials also contain a very low percentage of cinchona alkaloids, which it would be highly uneconomical to extract by the solvent process at present in vogue. But as the relative weight of the waste fraction is high compared with that of the bark, the actual amount of alkaloids that is thrown away becomes considerable. The approximate average proportions by weight of the different parts of cinchona plants and their alkaloid contents for a 3-year old cinchona tree, are given below:

TABLE

	Weight percentage of total	Alkaloid content	
		percentage of weight of material	percentage of total content
Bark	21	3.0	64
Wood	47	0.5	25
Twigs	13	0.4	6
Leaves	19	0.25	5

* Work in these directions is proceeding in the Bengal Immunity Research Laboratory and the preliminary results have recently been communicated to the *Journal* of the Institution of Chemists (India).

It will be seen that the waste fractions comprise 36 per cent of the total alkaloids contained in the cinchona and these amount to about 56 per cent of the alkaloid contained in the bark. The actual waste of cinchona alkaloids from the Indian plantations can be ascertained from the above proportions. According to the Report of the Principal Quinine Officer of the Government of India for the year 1944-45, the production of quinine sulphate was 101,419 lbs. and that of cinchona febrifuge (a mixture containing about 80 per cent of the cinchona alkaloids mostly other than quinine) was 62,355 lbs. during that year. These figures correspond to a recovery of about 124,427 lbs. of total cinchona alkaloids from bark, and the quantity of alkaloids thrown away with the waste fractions would therefore amount to about 69,679 lbs. It can be easily imagined what relief could have been brought to the millions of malaria patients, left untreated, if these 69,679 lbs of cinchona alkaloids were recovered and were made available for their treatment.

Of the waste fractions again, wood contains the major part of the alkaloids and since the relative proportion of wood increases at the expense of leaves with increasing age of the tree, this constitutes the most important fraction in connection with the extraction of alkaloids. It is clear therefore that if the acid extraction method including the adsorption of alkaloids can be adapted for the large scale extraction of the waste cinchona fractions, and particularly of the wood, on an economic basis, this by itself would be of immense benefit to the country at the present time.

A cheap process for the extraction of quinine will not only be of help in the present emergency but will certainly replace the present costly method of quinine production altogether. India is a poor country, and to quote Mr Calder (formerly Superintendent, of Cinchona cultivation, Bengal), "Malaria is a poor man's disease while quinine is a rich man's remedy". To produce more quinine and cheaper quinine is therefore the need of the day.

ON THE SECOND SYMPOSIUM ON THE AGE OF THE SALINE SERIES IN THE SALT RANGE OF THE PUNJAB

TWO antagonistic theses on the age of the Saline Series in the Salt Range of the Punjab[1] are still maintained by the contributors to the Second Symposium[2] held on the subject in December 1945. The views are frankly opposed to each other.

The two primary lines of evidence advanced in the present controversy are (1) palaeontological evidence indicating a wealth of microfossils of Tertiary age in the salt marl and associated rocks, and (2) "field evidence for stratigraphic continuity between the Saline Series and the acknowledged Cambrian beds". The proliferation of palaeontological evidence admirably put forward by Sahni and his collaborators, and the finding of microfossils, *e.g.*, woods of conifers & angiosperms, cuticles of grasses, chitinous parts of insects etc. and their repeated occurrence in various rock samples (including the oil shales where it is very hard to imagine that they could be other than *in situ*) at widely different localities clearly indicate an Eocene or later age for the Saline Series. But from the field evidence Gee (pp. 95-115)† and others have shown that the Saline Series is in its normal position when below the Purple Sandstone Series (Cambrian), and in sections with indications of a normal sedimentary overlap of the overlying Talchirs (Carboniferous), and as such Cambrian or pre-Cambrian in age. Wadia (p. 251) and Davies (1944, 1945, [2,3]) hold that the infra-Cambrian position of the Saline Series is due to tectonic movements. Still others (Lamba, pp. 31-32; Krishnan & Aiyengar, p. 90, Dar, p. 226) believe that the Punjab Saline Series and Kohat Saline Series (of known Tertiary age) either belong to one sedimentary origin or of the same age.

As against Sahni's discovery of microfossils in the Saline Series, Gee (p. 112) points out that these microfragments were not of indigenous origin. "Percolating ground-water could certainly carry microscopic, buoyant plant-fragments for considerable distances into the readily soluble rocksalt and possibly into the less soluble gypsum and porous dolomite. It is, however, more difficult to imagine the same phenomenon taking place in the Kerogen shales". Supporting Gee's idea, Sir Lewis Fermor (p. 38) holds that the plasticity and incompetence (in the stratigraphical sense) of the Saline Series is responsible for such contamination. Likewise, (L...ner p. 83) hypothesizes the possibility of admixture of Eocene salt containing contemporaneous microfossils to Cambrian salt during the so-called Salt Range thrust. Most of the geologists of the Cambrian school have attempted to explain away the presence of microfossils in some such ways. But they have either avoided or failed to explain the occurrence of the flora and fauna in the Kerogen shales. Rao (p. 256) points out that the organic remains which the Kerogen shales contain in each case definitely belong to the contemporary floras and faunas. It has also been emphatically observed by Wadia (p. 250) that "it is hard to believe or discount the evidence of fossils as presented by Sahni and his collaborators in their later papers. Incompetence of strata, their plastic flow, crumpling and solution channels do not give satisfactory explanation of the presence of micro-organisms‡ in the beds of rocks penetrated by borings of over 100 ft."

Sahni (p. xlv) claims that his fossil specks are all *in situ* materials contemporaneous with the rocks, which therefore cannot be other than Tertiary. Fossil evidence usually corresponds to field evidence. If they disagree, "it is the direct evidence of the fossils that is to be relied upon: palaeontology is a surer foundation for stratigraphy than field evidence." In view that the megafossils are absent microfossils are perhaps stated by Sahni to be of more use in stratigraphy than the megafossils (p. xlvi). But it should be made clear that foraminifera of derived origin have already been recorded from the Saline Series (pp. 37 & 218), and that the microfossil technique has not yet proved itself definitely more helpful than megafossil data in stratigraphical work. Gee (p. 96) has further attempted to discredit the microflora on the ground that it may belong to Cambrian. This suggestion is, however, untenable. Anyway, it must be admitted that the palaeontological evidence still stands strong.

Gee (pp. 99-112) has given a well-illustrated and convincing account of a number of additional critical exposures to support his contention in favour of Cambrian age for the Saline Series. A few of the important results of his fresh approach to the problem include (1) occurrence of pink gypsum as pebbles and one large boulder (probably of the Saline Series of that locality), near hill 1127 north-east of Dauk Khel in the eastern end of the Salt Range, in the lower part of the Talchir conglomerates, indicating a pre-Talchir age for the Saline Series, (2) normal sedimentary contact between Talchirs and

† References to pages are of the published account of the Second Symposium (National Academy of Science, Allahabad).

‡ The word 'microfossils' would have been more appropriate instead of 'micro-organisms'.

4

the underlying Saline Series in the Bhodha Wahan area west of Ratta and that the sequence of beds of the Saline Series resemble the one underlying the Purple Sandstone at Amb, (3) gypsum-dolomite oil shale sequence has been confirmed as occurring below the Salt Marl stage and a part of the Saline Series, (4) certain lithological similarities between the rocks of the Saline Series and the overlying Cambrian beds, (5) interbedding between the oil shales of the Saline Series and the Cambrian (or pre-Cambrian) dolomites of the upper stage of the series near Ratta, below Sakesar. These field evidences together with those reported in the last symposium that in sections the junctions of the Saline Series and the overlying Purple sandstones (Cambrian or pre-Cambrian) and Talchir boulder bed (Carboniferous) are of normal sedimentary nature, convincingly prove that the Punjab Saline Series is of Cambrian (or older) age.

Rao ((pp. 218-219) and Wadia (p. 251) doubt the reliability of the critical sections in question. They hold that many of the tectonic junctions may simulate the so-called normal sedimentary contacts. Rao, however, also considers the possibility of acceptance of Gee's views. In the light of deceptive field relations existing in the north and west of the Salt Range, Davies (p. 41) also suspects the field evidence claimed by Gee & others, "for the basal Cambrian age of the Punjab salt." However, most of these arguments appear to be indirect or negative proof against Gee's contention.

Lamba (p.32), Krishnan & Aiyengar (p. 90) and others have pointed out important lithological similarities between the Saline Series of the Punjab & Kohat. Since Kohat salt has been proved to be of Tertiary origin, they are convinced of the improbability of having two salt deposits of such widely different ages in close proximity to each other. The bore-hole records of the sequence of oil horizons and grey salt in Saline Series appear to have a sort of affinity with the similar materials in Kohat (Lamba, pp. 31-32). The situation becomes more intriguing when the salt deposits of Mandi State (of assumed Tertiary age) are taken into consideration. "Then we have a separate block of Cambrian salt of the Salt Range area, so to speak, wedged in between the Tertiary salt of the Trans-Indus region in the west and the Tertiary salt of Mandi State towards the head of the gulf in the north-east" (Dar. p. 226).

Gee (pp. 113-115) explains away the lithological similarities as having no direct relatiop to geological age, and that the occurrence of more than one salt deposits of different ages in the neighbouring localities is much less of a coincidence in the geological history of the Salt Range-Potwar-Kohat region.

Wadia (p. 251) complains that the importance of thrusts in the Salt Range geology has not been properly recognized by the geologists of the Cambrian school. It should be noted in this connection that Gee & others have repeatedly admitted thrust structures in the Salt Range, "but these do not necessiate a regional thrust".

It seems extremely difficult to reconcile the opposing interpretations presented by different contributors of the Second Symposium. Suggestions for future research have, however, been made for palaeobotanical analysis of control rock specimens of undoubted Cambrian age to examine the validity of the contamination theory put forward by a number of geologists (p. 115). Accordingly Hsu (pp. 92-94) attempted to recover microfossils from the Purple Sandstone (Cambrian or older) and obtained negative result.

But more recently Ghosh and Bose (1947)[4] and Ghosh, Sen & Bose (1948)[5] have recovered a wealth of microfossils (which include pteridophytes, gymnosperms and angiosperms*), from the Saline Series and all the overlying Cambrian beds. The Vindhyan rocks have been found to be unfossiliferous. From the data at hand, *i.e.*, the occurrence of microfossils in beds overlying the Saline Series of undisputed age (as stated above), it is necessary that further extensive work be carried out, for confirmation of the conclusion drawn by Sahni on the age of the Series in question. The other possibility that all the Cambrian beds referred to belong to post-Cambrian may also be considered, if advisable. This is a matter to be decided by the geologists. However, it should be made clear that all micropalaeontological data need checking with the help of control. The reviewer has not yet heard about the result of radio-active analysis of the Khewra Trap as mentioned by Sahni (p. 243).

I. S.

* Angiospermous microfossils recovered from Saline Series and Salt Pseudomorph beds.

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SOME SCIENTIFIC AND PRACTICAL PROBLEMS OF AGRICULTURE IN INDIA*

J. N. MUKHERJEE

DIRECTOR, INDIAN AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI

THE problems of production of food and raw materials for industries from the land are part and parcel of a bigger proposition and one can ill-afford to lose sight of the wood because of the trees. In fact, it will not only be short-sighted but disastrous to ignore the wider aspects. This more comprehensive issue is the preservation, beneficiation, and ecologically balanced utilization of our natural resources of climate, soil, water and of land and animal life. We should aim at systems of permanent agriculture and other forms of land and water utilization which are suited to the diverse conditions of soil and climate so as to meet our local, regional and national needs.

Nature tends to build up in course of time an ecological balance. Climate, soil, plants, animals and man constitute a complex association; each acting and reacting on the other to a more or less degree. Man has the power and apparently the right to modify many aspects of it to suit his needs. "Resource depletion and impairment are as old as mankind and as widespread as the inhabited portions of the earth. But in most primitive societies resources have been abandoned in proportion to the needs so that the supply has been adequate despite destruction. Moreover, when the resources, such as grain, have been narrowly limited, these people have moved down to fresh areas and not returned until nature has gained time to restore the damage."

A programme of conservation includes in the case of renewable resources measures of preservation which will guarantee their quantity and quality, restore, so far as is desirable and humanly possible, the biotic, soil and water resources. It should include not only the restoration of resources to their former natural state of productivity where this has been damaged, but also wherever possible "the stepping up of that prductivity to a level above that which nature unaided has reached." This improvement of resources has been designated "beneficiation". Reclamation of a source, such as desert land or swamp land, which is non-productive is another aspect of improvement. This beneficiation is a necessity in order to maintain, restore or create a satisfactory balance between man and his resources. In the past, beneficiation has been worked out by man through the empirical methods of trial and error applied by generations all over the earth. Science has, with the help of its methods and techniques, rendered such beneficiation much more certain, a matter of conscious planning and possible on a vastly enlarged scale. For non-renewable resources, such as minerals, efficient production and use must be the sole objective in order that they are not wasted. Recovery and re-use are intimately connected with their optimum utilization, as also is the substitution of one resource which is ample to meet the functions of another which is not so.

For all these purposes what is wanted is an appreciation of the supreme importance of the conservation of natural resources including their beneficiation and of their judicious use. A statutory permanent organization at the highest level of science and administration is necessary to ensure the continuity of policy regarding the conservation and utilization of resources. Such an organization should be a necessary part of a National Planning Board.

SCIENTIFIC BACKGROUND OF AGRICULTURE

Agriculture does not mean only the production of crops. Together with forestry, fisheries, irrigation and other forms of use of water, preservation of wild life and scenic beauties, it deals with the conservation of optimum utilization of climatic, biotic, soil and water resources.

Increasing attention is now being paid by men of science to the ecological aspects of agriculture and other forms of utilization of renewable resources. In its broader sense, ecology includes the study of man in relation to his environment and this concept is of value in the training of the agronomist as also in dealing with projects of agricultural improvement. The subjects of plant and animal ecology have a more direct bearing on crop production. The climate, the soil and the moisture regime of the soil are the most important factors, which determine the suitability and economic possibilities of a crop in a region. It must fit into the ecological setting. The plant breeder continuously strives to evolve plants which will thrive best in this setting and have power to resist pests and diseases, droughts or floods, or saline condition under which it will be grown. In introducing exotic plants a study of ecological factors is necessary. Climatic surveys, ecological plant geo-

* Adapted from the Ninth Sir J. C. Bose Memorial Lecture delivered at the Bose Institute on 30-11-1947 (see SCIENCE AND CULTURE, January, 1948, p. 284).

graphy, distribution of soil zones, soil groups and types are all factors of importance in plant introduction. Similarly, a study of insect ecology is of great importance in the control of pests.

The soundness of a system of cropping is determined by its stability. An improvement has to be judged by its long term effect on the land and its productivity. The features of permanent agriculture are determined by complex ecological relationships. It is possible to build up soil fertility and to maintain it at an optimum level. This is an example of beneficiation of a natural resource. The effect the cropping system, the manurial treatments and cultural and other practices have on the land and its productivity determines its suitability. The cropping system and treatments of soil and other agricultural practices have to be fitted in the soil-climatic complex in order that they are of permanent value in conserving the soil and its productivity. To achieve this objective crop rotations have been and are being evolved in different countries in which the soil-depleting crops, such as cereals and some cash crops are balanced with soil-improving and soil-building legumes and grasses. Intensive search of suitable legume which can fit in the climatic and soil conditions and also seasons of the year is being made in many countries.

One of the most important items of our short- and long-term research should be to undertake, on a wide scale, experiments with a view to evolving systems of cropping, manuring and correlated soil and crop management which will give us optimum production for each distinct type of soil on the basis of permanent agriculture. The set-up of commodity committees unfortunately detracts attention from the general problems of soil productivity and crop production as it emphasises the study of single crops in isolation. This is a defect of scientific approach which urgently calls for remedy. It also relegates the distinct study of the soil to the background as the soil studies should not be and cannot be conducted piecemeal in relation to the needs of individual crops.

Intensified Effort for Food Production

The present average yield per acre of our crops is unfortunately very low. On the other hand, we have the encouraging evidence for many crops that the innate productivities of our soil are not low and that a high level of productivity can be attained. Even under existing conditions there is a striking difference between the average maximum and average minimum yields of the same variety of crop in the same village. While part of this is due to innate soil differences, quite a substantial part is due to factors which are capable of immediate remedy. Another advantage we have is that two, even three crops, may be raised from the same plot of land. An increase in the intensity of cropping is an immediate possibility, especially as regards extension of cultivation of vegetables and some other crops in areas adjoining villages if certain difficulties could be removed. By far the major part of agricultural production is the job of the rural population scattered over about six hundred thousand villages (including Pakistan). It is the job of the least literate and resourceful section of the population.

A very important omission in the set-up of the Agricultural Departments of India as compared with that of countries like the U. S. A., U. K., Canada, Australia, etc., is the opposite number of the County Agent or the Agricultural Inspector etc., as they are designated in those countries. The duty of these men is to help the farming communities to organize themselves, to understand their difficulties, to bring the latter to the notice of other Government agencies and generally serve as a link of contact between them and official agencies who can help them with technical advice, materials etc., for increasing efficiency and introducing improvements. The County Agents get into touch with the respective State Departments and draw upon the staff of the latter for helping the solution of the difficulties of the former. An energetic effort commensurate with our problem, a definite organization on a country-wide scale, is immediately necessary.

The United Kingdom during the War set up War Agricultural Committees in every country. They functioned very well and contributed significantly to the achievement of increasing crop production by about 70 per cent. They were the active links between the State and the farmer. In the U. S. A about 90% of the contemplated target of production was achieved during the War. In the U. S. A. the extension service and the soil conservation service form two characteristic organizations which concern themselves respectively with the extension of the results of experiments to the farmer's fields and with soil conservation measures in them. Similar organizations may be set up in our country and their objective and functions as also their relations with the Agricultural Departments may be clearly defined.

For the immediate programme we have to draw upon the knowledge we already possess. There are three sources of such knowledge:—

(1) that which the efficient farmer has;

(2) that available at our experimental stations;

(3) what has been gathered in the different countries of the world after years of experimentation. The broad scientific

conclusions deduced from the latter source, especially where it is corroborated by experiments in India, should also obviously be suitable for use in the immediate programme.

A critical scrutiny by competent men may, however, be necessary.

Manurial Experiments

Experiments in India and the experimence of the good farmer show that soil fertility can be built up by judicious manuring, cultural practices etc. A large-scale trial with paddy on 27 acres of land in Mysore has demonstrated that the average yield per acre could be raised from about 1450 lbs. to 3200 lbs. A mixture of oilcake and superphosphate (the latter being replaced in later years by bonemeal and calcined tricalcic phosphate) supplying 12 lb. of nitrogen and 18 lb. of phosphoric acid per acre and 1 to 1½ tons of cattle manure were used. The permanent manurial experiments at Pusa (Bihar) also show agreement with what our peasants already know that farmyard manure can build up and maintain soil fertility. These experiments have also shown that green manure fertilized with phosphates is almost as good a substitute for heavy doses of farmyard manure. Oilcakes were also found to be very efficient for this purpose. Even a mixture of all the three major fertilizing ingredients, N, K, Phosphates in the form of artificials, increased the yield. The use of green manure is very well known to the Indian peasant and he has been using it for centuries mostly under rainfed conditions. Although manurial experiments have not always been properly conducted in the past and are rarely correlated with the soil type, the balance of evidence clearly shows that our soils generally respond to a combination of nitrogen and phosphate. It is possible that with the use of heavy doses of both the response and higher crop yields may be found with potash also.

The total allocation of nitrogenous fertilizers to India is two hundred thousand tons. Our internal production from all sources including the coke and gas ovens if fully utilized may add a maximum of another 40 to 50 thousand tons. This is quite inadequate to meet our purposes. It will be some time before the contemplated Government factory at Sindri comes into production. Also, our requirements of nitrogenous and phosphatic fertilizers may ultimately, when their values have been established and demand created, run into a few million tons of each. We have neither sufficient farmyard manure nor oilcakes to meet our fertilizer needs. Besides, oilcakes constitute one of our most important cattle-feeds. Use of green manures and super-phosphates, or in regions of acid soils bonemeal, constitutes a way out of our difficulties. The permanent manurial experiments in Pusa (Bihar) show that the quantity of fertilizers added from external sources to the land is the least when green manures and super-phosphates are used. Besides, only phosphatic fertilizers are required. It is, however, not meant to convey that nitrogenous fertilizers are not required in quantities. The point is that we cannot have them in sufficient quantities. The estimated output of bones per year in India is about one million tons. I cannot say how far these figures are accurate. But not more than 5% of this quantity is utilized at present. There is considerable difficulty in collecting the bones. An intensive effort should, however, be made to utilize them for manurial (as also industrial) purposes. It should be possible to import 'super' in large quantities or phosphatic rocks and sands for conversion into it.

In many areas the rainfall is quite good, but much of it runs to waste. Evaporation and desiccation by scorching dry winds is one of the causes of this waste. An extensive programme of planting of trees as wind breaks, which also give protection against damage by storms, should be embarked upon immediately. Quickly growing trees for supplying fuel to the villages, fruit trees, fodder trees and in general trees of importance in rural economy should be chosen for this purpose. Villages I know of in detail do contain trees of economic importance and they used to contain more of them when I was young. Some of them must have been imported from other areas and established in the villages. It seems that the importance of wind-breaks and the beneficial effect of trees has been long recognized in our country. The trees planted on the sides of tanks in many parts of the country bear testimony to this.

In many areas where rainfall is scarce, developments of pasture and of trees offer greater scope. If we simply look on the immediate measures, we shall be postponing the day for more fundamental and profitable solution of our problems. The immediate programme has, therefore, to be dovetailed into their 'near immediate' and 'ultimate' aspects. A thorough survey of our underground water resources should be taken up immediately and a great deal could be done in the matter of water conservation.

Another measure which requires a more intensive drive is the production of better seeds by peasants locally. If the good peasant could be interested, there should not be much difficulty in pushing up the production of good seeds.

There is a great variation in yield of the same crop and perhaps of the same variety in the same village. Innate soil differences and lack of manures and fertilizers are two possible reasons. Also, want

of facilities and labour for timely cultural operations is another. Yield from land, which is not cultivated by the farmers commanding adequate facilities, is generally very low. This class of men has to depend upon pursuits other than agriculture to supplement their income from it. The percentage of such not-properly-cared-for land seems to be considerable. We should therefore immediately concentrate on raising the level of yield of these areas to what is possible by drawing upon the knowledge of the good farmer in the village itself.

An all-out effort and a well planned organization as indicated above in rough outline are required to make possible a purposeful and sustained drive. In the rural areas there are men with intelligent self interest and idealism, knowledge of local conditions and conscious of the needs of the situation. It should be possible to obtain their co-operation and with their help organize the work in the villages. Prizes, shows, monetary rewards, certificates of merit etc. may be arranged to encourage the farmer and to be efficient the best fields may be utilized for purposes of demonstration.

We cannot afford to neglect any factor, the adoption of which is feasible and will contribute to the objective. The cumulative effect of all these factors, some of which individually may not be considered to be of much significance, is very great indeed. It is also neither purposeful nor helpful to limit our efforts to increased production of food crops. Animal husbandry, fisheries and commercial crops should receive simultaneous attention.

Notes and News

INDIAN INSTITUTE OF METALS

THE inaugural meeting of the Institute, as announced earlier (See *Science and Culture*, December, 1947, p. 147) was held in Calcutta, on December 29, 1947, Sir J. J. Ghandy presiding.

Inaugurating the Institute, Dr S. P. Mookerjee, Minister for Industries and Supplies, Government of India, said that a new era was about to open in the field of metal production. Until now India's mineral industry was not fully harnessed to provide for her industrial development. As a result, barring coal and iron ore, the bulk of her mineral resources had been exploited solely for export.

The basic metal production in India today was about 1,000,000 tons of steel, 6,000 tons of copper, 4,000 tons of aluminium, a few hundred tons of antimony and a negligible quantity of lead, but the country's requirement of these metals was many times greater. In addition, metals such as zinc, tin, nickel, tungsten and berylllium were not produced in the country and India had to depend on outside sources.

India, however, had sufficient resources for a great and well regionalized metallurgical and heavy engineering industry as well as for mineral-based heavy chemical and other industries. There were vast deposits of iron ore and bauxite and proper development of steel and aluminium industries alone would be able to make India stand on her own legs.

Dr Mookerjee hoped that the Institute could bring home to its members and through them to the public an idea of the resources available in the country and also serve technologists for processing, design or construction.

In his presidential address, Sir Jehangir Ghandy referred to the Central Government's decision to accept the Iron and Steel Panel's recommendation for the establishment of two new steel plants with initial and ultimate capacity of 500,000 tons and 1,000,000 tons respectively. He said that private enterprise was in a position to own and manage them under certain conditions, or, if necessary, would agree to joint ownership with the government. It was, however, essential to exclude provincial governments from participation in them. Speaking on industry in general, he deprecated nationalization, which engendered a sense of insecurity and nervousness in industrial circles.

The following were elected to the Council of the Institute for the year 1948: *President*—Sir J. J. Ghandy; *Vice-President*: Dr D. R. Malhotra and Mr J. S. Vatchagandhy; *Treasurer*: Mr C. J. Shah; *Secretary*: Dr D. P. Antia.

MINING, GEOLOGICAL AND METALLURGICAL INSTITUTE OF INDIA

In his presidential address at the forty-second Annual General meeting of the Institute, held at Calcutta on January 30, 1948, Mr J. K. Dholakia, the retiring president of the Institute, stressed the need for large-scale mechanization and organization of the coal mines in India in order to attain the target production of 42 million tons ten years hence as envisaged by the Indian Coalfield Committee. He suggested the formation of a committee to examine the possibilities of developments in regions and to co-ordinate and execute them in such a way that it can be a prelude to the future planned production policy.

Continuing Mr Dholakia emphasized that industries should not be nationalized and private enterprise should be allowed to work with its capital and brains to help the Government towards the industrial advancement of the country on a co-ordinated plan.

The following were elected office-bearers for the year 1948-49: *President*: Dr W. D. West; *Honorary Secretary*: Dr P. K. Ghosh; *Editor of Transactions*: Dr M. S. Krishnan.

The Government of India Prize and the Institute's Gold Medal were awarded to Dr H. Crookshank of the Geological Survey of India for his work on Minerals of the Rajputana Pegmatites.

The Institute's Silver and Bronze Medals were awarded to Dr G. Dessau of the Geological Survey of India for his work on geophysical prospecting in India and to Sri A. K. Ghosh of Calcutta University College of Science and Technology for his work on microfossils respectively.

BANGIYA BIJNAN PARISHAD

The inaugural meeting of the *Parishad* as announced earlier (See *Science and Culture*, December, 1947, p. 248) was held in Calcutta on January 25 last, Sri Rajsekhar Bose presiding. Prof. P. N. Banerji, Vice-Chancellor, Calcutta University was the chief guest on the occasion.

Inaugurating the *Parishad*, the Vice-Chancellor hoped that rich fruits would be available by studying science through the medium of mother tongue. He said the University had almost decided to introduce Bengali in all its courses. It was only a matter of few years when they would be fully prepared for the complete success of this project. In his opinion examinees in the Intermediate and B.Sc. (Pass) courses should from now be allowed the option of answering the question papers in Bengali.

Speaking on the subject of Scientific Terminology in Bengali, Sri Bose narrated the history of development of such terminologies, and said there were two schools of thought prevailing. One school led by Sri Jogesh Chandra Roy was in favour of retention of English terminologies, while the other stressed the need for coining every word in Bengali. He explained with illustrations the relative merits of these two lines of argument.

The following were elected office bearers of the *Parishad* for the year 1948: *President*: Prof. S. N. Bose; *Vice-Presidents*: Prof. K. P. Chattopadhyaya, Dr S. C. Law and Dr S. C. Mitra; *Treasurer*: Dr J. Gupta; *Honorary Secretary*: Dr S. N. Bagchi.

Dr Sundari Mohan Das and Sri Jogesh Chandra Roy, Vidyanidhi were elected Honorary Foundation Members of the *Parishad*. About 500 members were enrolled as Foundation Members of the *Parishad*.

The importance and necessity of disseminating scientific knowledge in vernacular with a view to helping speedy development of our land and people, where much is to be achieved in short time, will be admitted on all hands. The timely publication of the monthly Bengali journal, *Jnan-O-Bijnan*, entirely devoted to scientific and allied subjects, one of the first activities of the *Parishad*, has been a move in the right direction. The objective laid down, *viz.*, to discuss scientific topics in the easiest language so as to be appreciated by the ordinary reader is laudable, though it may not be easy. The editor has done well to emphasize the greatly changed circumstances today from the past when publications of similar nature proved to serve no useful purpose and had to be eventually abandoned. The list of contributors includes the names of such well-known personalities as Sri Jogesh Chandra Roy, Sri Binoy Kumar Sarkar, Sri Charu Chandra Bhattacharyya, etc. and bears testimony to the enthusiasm and active support which the venture, if properly sustained, is likely to receive.

ROYAL ASIATIC SOCIETY OF BENGAL

Speaking at the Annual General meeting of the Society held in Calcutta, on January 16 last, H. E. Sri C. Rajagopalachari, commended the valuable work done by the Society in the realm of Ancient Asian and Indian culture and history. He added that their work was no less patriotic than of those who had devoted themselves to the task of political and industrial advancement of the country. By their

works, the Society was enhancing the self-respect of the people and making a most valuable addition to the cultural wealth of the country.

Dr B. C. Law, the retiring president, gave a brief survey of the Indological researches carried out so far. India could ill afford to neglect investigations concerning herself and Asia, if she really aspired to take her rightful place in the comity of nations.

Continuing Dr Law said that the attention of the modern world was drawn as much to prehistoric periods and geological ages as to historical times. The unlocking of the secrets of the fossils of fauna and flora as clear vestiges of the past history of their evolution became as important as that of the secrets of various ancient monuments and their inscriptions as precious remnants of the great achievements of man in the past ages. The decipherment of the hieroglyphic and other pictographs, and of the *Brāhmi* and the *Kharosti* inscriptions in India, were remarkable attainments. Culture and civilization in every country were composites in the sense that there was no isolated development anywhere. There existed an inter-related and inter-dependent system of change as much in the formation of land and water, mountains and rivers, as in the evolution of different species of living beings, of human races, their languages, thoughts and ideas.

Presenting the annual report the General Secretary, Dr K. N. Bagchi, said that the year under review had been one of great activity in all the branches of the Society. The membership has now risen to 1,016 as against 928 in 1946.

The following were elected as officers of the Society for 1948: *President*: Dr W. D. West; *Vice-Presidents*: Dr B. C. Law, Maharajadhiraja Bahadur Sir U. C. Mahatab of Burdwan, Sir B. L. Mitter and Prof. M. N. Saha; *Treasurer*: Mr K. P. Khaitan; *General Secretary*: Dr K. N. Bagchi; *Library Secretary*: Dr B. S. Guha.

Dr D. R. Bhandarkar, former Carmichael Professor of Ancient Indian History and Culture, Calcutta University was elected an Honorary Fellow of the Society.

The following awards were anounced: *Barclay Memorial Medal* for Biological Science to Rai Bahadur K. C. Mehta, Agra; *Joy Gobinda Law Memorial Medal* for Zoological studies to Dr Lieven Ferdinand de Beaufort, Amsterdam; *Paul Johannes Brühl Memorial Medal* for Botanical Studies to Prof. S. R. Bose, Calcutta; *Dr Bimala Churn Law Gold Medal* for History and allied subjects to Dr B. M. Barua, Calcutta; *Sir Jadunath Sarkar Gold Medal* for History and allied subjects to Sir Panduranga S. S. Pisurlencar.

SILVER JUBILEE OF SWEDISH STANDARDS ASSOCIATION

The Silver Jubilee of Swedish Standards Association was celebrated on September 25-27 last by a large congress in Stockholm, attended by over 700 delegates. The principal foreign guest was Mr Charles le Maistre. He represented the Central Office of ISO, which had also sent its Treasurer, Mr Streiff of Switzerland. The Standards organizations of the Northern countries were represented by delegates from Denmark, Finland and Norway.

The Congress was opened by Mr Hilding Tornebohm, President of Swedish Standards Association, who read a paper on the Technique of Standardization. Stressing the importance of a mathematical training for the standardizing engineer, he mentioned the various mathematical series that might be of interest in standardization. A standardizing engineer, said Mr Tornebohm, must moreover be able to coordinate differing desiderata, and it has been said that he must be 85% diplomat and 15% technician. A standardizing exhibition, probably the first of its kind in the world, formed a part of the ceremony. Mr le Maistre gave a short address on "Industrial Standardization, Today and Tomorrow".

Mr Lennart Bergvall, Architect, spoke on the module for coordination in building design. The Swedish proposal of a 10 cm module closely agrees with the American 4″ module. Agricultural standardization problems were thoroughly discussed, the hydraulic plough lifts being, for instance, criticized on the grounds of their differing practically in every make of plough The placing and design of tractor driving shafts for coupling to threshers, etc approved as Swedish Standards were also described; these conform to American practice.

Loading pallets permitting the despatch of "Unit loads" to simplify transport was another point on the programme, in regard to which Mr T. Prambere related American experience. Mr G. Meyerson's paper dealt with another aspect of the rationalization of distribution, *viz.*, the standardization of containers; he pointed out that approximately half the cost, to the consumer, of an article falls on its packaging, distribution and selling, and that rationalization with a view to the cutting down of these costs is accordingly at least as important as the reduction of the actual manufacturing costs.

That unsuitable designs of objects and implements are often used in our daily life from sheer habit was pointed out by Mr R. Kristensson, who gave as an example the ordinary tea spoon, which for comfortable use really ought to have a less acute angle between the bowl and the handle.

The papers read before the Electrical Section occupied a whole forenoon. Mr Malm spoke of the differences in materials between Swedish and American installations due to differing types of network used in the two countries; the American system of 2×115 V gives at most 115 V to ground, while the Swedish practice of using 3-phase 3×380 V gives 220 V to ground, and therefore requires quite different insulation, etc. The standardization of incandescent lamps now proceeding in Sweden was described by Mr B. Tranaeus, and Mr E Stenkvist gave an account of the work in regard to transformer standards in which due regard is being paid to developments in other countries.

Mr. N. Sonesson spoke of standard grading for potatoes, apples, roots, etc., in respect of which a good deal of progress had been made and Mrs Eva von Zweigbergk discoursed on standardization in a home such as house-wives might dream of.

The metallurgists discussed standardization of tool and structural steels; the standardization of graphical symbols and signs was the subject of four papers. International standardization was also dealt with in connexion with two papers on the organization of international air traffic.

COLLECTION OF CULTURES OF MICRO-ORGANISMS

The setting up of an organization to be known as the 'British Commonwealth Collections of Micro-organisms' is recommended in a report, based on the Conference held in London in August, 1947 on "Culture Collections of Micro-organisms" (H.M.S.O., Kingsway, London, W.C.2, Price six pence). Dr H. J Thornton F.R.S. was chairman of the conference. A research worker who is studying human, animal or plant diseases, often requires authentic cultures of the organisms responsible. He needs them either to help him to identify the parasites he has isolated or to test new drugs or treatments. There is also an increasing demand from industry for strains of fungi, yeast and bacteria having certain specified biochemical characteristics, such as for edible yeasts or brewing, the production of streptomycin, etc. On the recommendation of the British Commonwealth Scientific Official Conference, 1946, a Specialists Conference was held in August, 1947 to consider these problems. The recommendations now made are:

(a) an organization known as the British Commonwealth Collections of Micro-organisms should be established to foster the maintenance of existing collections, to make the cultures in these collections more fully available for general use, and to encourage the establishment of such new collections as may be necessary.

(b) a Permanent Committee should be set up in London to provide for the central administration of this Commonwealth Organization:

(c) one of the duties of this Committee should be the preparation of a directory of collections and catalogues of cultures in the collections.

The Conference recommended that those looking after the collection should be encouraged to carry out research on the organisms in their charge and on the best means of maintaining them in vigorous and active condition. The Conference also suggested certain standard procedure for the referencing and cataloguing of the organisms in a collection and for the distribution of cultures. As regards dangerous human, animal or plant pathogens, the Conference recommended that they should be sent to a territory only after the quarantine and other restrictions that may be in force, have been complied with.

Mr M. Sreenivasaya, lecturer in fermentation technology, Indian Institute of Science, Bangalore, has been nominated as a member of the Permanent Committee of the Commonwealth Collection of Type Cultures in London.

SYNTHESIS OF VITAMIN A

The oil-soluble Vitamin A was discovered as early as 1913, its composition having been known since 1931. So far it has proved impossible to prepare this vitamin artificially, which is possible for all the other vitamins. Nobody has ever been able to confirm the statement published by Kuhn and Morris in 1937 that they should have succeeded in synthesizing Vitamin A, though the problem has been studied in many laboratories all over the world. After 4 years' research, Dutch chemists (in Pharmaceutical Industry), Dr J. F. Arens and Dr D. Ven Dorp have succeeded in synthesizing this vitamin in the Organen Laboratories at Oss (Holland).

Both for medical purposes and for the vitaminization of foodstuffs (*e.g.* margarine) highly concentrated vitamin A preparations are required. Until now these products could be prepared only from fish-liver oils, which are largely lacking throughout the world. Dutch investigators (Eykman & Grijns, Jansen & Donath) had earlier performed spadework in the vitamin B_1 field, and further chemical work in the vitamin field was done, for the greater part, in America.

NOVEL PILE FOR SCIENTIFIC RESEARCH

THE National Laboratory of Brookhaven in the State of New York has commenced construction of an atomic pile costing nearly six million dollars. It will be used for researches on the pacific utilization of atomic energy, particularly in the domain of physics, chemistry, biology and medicine. This laboratory will be directed by an Association of the Universities of the Eastern States of U S A and a great number of specialists will benefit from the new installation.

The density of neutrons of the Brookhaven pile will be many times larger than that of the Oakridge pile which has not ceased during the year to furnish radio-active isotopes for researches in biology and medicine. Mr Sumner Pike, a member of the Atomic Energy Commission of U.S.A has outlined the importance of this new laboratory and declared that a number of other laboratories will grow out of it. "We hope that, thanks to this laboratory, it will be possible to gather and diffuse knowledge which will be found useful in science and in industry. But what is more important, we hope to be able to help Universities in forming groups which will be capable of making progress for the utilization of the new instruments so that the annoyance provoked by this discovery having been dissipated once for all, the new tools will be definitely within the corpus of useful human knowledge, and ultimately may appear as natural and as easy to understand as the radio of our home." (From *La Nature*, Dec. 17, 1947)

INCREASED WORLD PETROLEUM SUPPLY

COMPARED with 1938, the world output of petroleum in 1947 has been about double, the estimate being 400,610 metric tons. *Petroleum Press Service* lists 22 countries producing from 250,000 metric tons (U.S A.) to 300 metric tons (Ecuador), and the 'other countries' (including India) has a capacity for a total of 1300 metric tons. The most striking advances in output are those of the U.S.A. and Venezuela, with Iran and Saudi Austria achieving even more spectacular outputs, if judged on the basis of percentage increase rather than on actual quantities. Egypt has advanced from 223 metric tons to 1300 metric tons. Decline is noticed in Rumania and Dutch East Indies, the reasons being war-destruction and difficulty of restoration. It is reported that a substantial part of the present supply is used as a raw material for the chemical industry. The U.S. Bureau of Mines is therefore aiming at a production of 2 million barrels of synthetic fuel from natural gas, coal and oil shale. The present estimated cost of this synthetic fuel is from 3 to 5 cents a gallon higher than the price of petrol but improvements in process may reduce the cost soon.

A NEW STANDARD OF LENGTH

THE wavelength of green radiation of mercury 198, an isotope transmuted from gold by neutron bombardment offers a new and superior standard of length. The U.S. National Bureau of Standards reports investigations on this subject. The present unit of length, the metre, represents one ten-millionth of the earth's quadrant. Earth's dimension is liable to change after a collision with a comet and to guard against this possibility a light wave in a vacuum as a standard of reference for length was long ago proposed! Later while proceeding with high precision work, it was discovered that the standard metre did not afford sufficient precision, and subsequently the red line of cadmium found universal use for many years for refined measurements. Mercury was thought to be a superior source of light but natural mercury consists of a fixed mixture of seven isotopes and the spectral lines have interfering components from the different isotopes. The feasibility of transmuting gold (Au^{197}) into Hg^{198} and thus getting a single pure source of mercury was first demonstrated in 1940 by bombarding gold with neutrons from the 60-inch cyclotron at California. In 1942, 40 ounces of proof gold was supplied by the National Bureau of Standards to California to expose this gold to neutron for one or more years. The war interrupted and only submicroscopic quantities of artificial mercury were made. In 1945 the work had been transferred to Tennessee atomic pile, which is a much stronger source of neutron, and a year later, after distillation 60 milligrams of Hg^{198} were obtained. Experiments are in progress for making on effective and convenient source of light with this mercury. It appears probable that either electrodeless tubes or Geissler tubes (similar to the luminous signs) containing several milligrams of mercury and a small amount of argon gas will serve well for accurate measurements.

THE XIIITH INTERNATIONAL ZOOLOGICAL CONGRESS

THE XIIIth International Congress of Zoology (see SCIENCE AND CULTURE, July 1947, p. 32) will be held in Paris from 21st to 27th July, 1948 under the Presidentship of Prof. Caullery, head of the permanent committee of Zoological Congress.

The fee for membership is 1000 francs and persons applying for enrolment should send their name, age, address and qualification to Prof. Fischer Piette, The Museum, 55 Rue de Buffon, Paris 5. The food and lodging in Paris for the members will be arranged at a reasonable cost. There will be excursions to England and to various parts of France proper.

The proceedings are divided into 10 sections: (1) general zoology, (2) evolution and genetics, (3) cytology and protistology, (4) comparative and experimental embrology, (5) vertebrates: (*a*) comparative anatomy and histology, (*b*) systematic zoology, (6) invertebrates except insects (systematics, anatomy, embryology, physiology), (7) entomology, (8) applied zoology and parasitology, (9) zoogeography and paleonotology, (10) nomenclature.

PROFESSOR PURNA CHANDRA MAHANTI

PROF. P. C. MAHANTI, whose appointment as Sir Rash Behary Ghosh professor of applied physics at Calcutta University was announced earlier (See SCIENCE AND CULTURE, December, 1947, p. 248), has been connected with the applied physics department of the University since its inception in 1925.

Educated at St. Xavier's College, Calcutta, Prof. Mahanti took his Master's degree in physics in 1925 and was soon after awarded the Sir Rashbehary Ghosh research scholarship in applied physics. He was appointed an assistant lecturer in 1927 and has been serving as a lecturer since 1932.

Dr Mahanti is one of the pioneer workers in the field of electrical measurements in India and his contributions to the knowledge of 'molecular spectra' have been acknowledged as very important and fundamental both in India and abroad. He was admitted to the degree of doctor of science of the Calcutta University in 1936. Earlier, he was awarded the Sir Asutosh Mookerjee Medal for the best original thesis in science in 1933.

Dr Mahanti is also responsible for the building up of a standardization Laboratory in the University which is the best in India and in this connection, he has to devise many ingenious instruments. He has been entrusted with some problems on design and manufacture of electrical measuring instruments under a scheme financed by the Council of Scientific and Industrial Research, Government of India.

Dr Mahanti visited Teddington and other laboratories in U. K. in 1946 as Sir Rash Behary Ghosh Travelling Fellow of the Calcutta University. He worked in the electricity division of the National Physical Laboratory and mastered all the techniques of electrical measurements of the highest precision, and also studied the practical aspects of electro-technics.

Dr Mahanti is the author of about fifty original papers published in various journals in India and abroad and has also been conducting original investigations by students working under his direction. His works are referred to in standard British, American and German text books on molecular spectra and allied subjects.

Dr Mahanti is a fellow of the Institute of Physics, London, and of the National Institute of Sciences of India; an associate of the American Institute of Electrical Engineers; and a member of the British Standards Institution. In 1943, Dr Mahanti was elected Honorary Secretary of the Indian Physical Society.

We hope that Prof. Mahanti would not only be able to maintain the traditions of this department created under the leadership of Prof. P. N. Ghosh, but will also be able to expand the useful activities of the department of which he assumes the charge as head of the department.

ANNOUNCEMENTS

DR. Sudhir Sen, former Economic Adviser to the Indian Embassy in Moscow, who is appointed Secretary, Damodar Valley Corporation will shortly take up his new appointment after a visit to the headquarters of TVA for consultation with TVA officials.

BEGINNING with 1947, the publication of the Geophysical Abstracts has been transferred from the U. S. Bureau of Mines to the Geological Survey, Department of Interior. The Abstracts are published quarterly as an aid to those engaged in geophysical research and exploration and covers a wide range of subjects. Copies may be had from the Superintendent of Documents, Government Printing Office, Washington 25, D.C. Price for each copy is 15 cents.

At the last Annual General Meeting of the Indian Ecological Society held at Patna on January 1 last, the following were elected Office-bearers for 1948: *President*: Dr T. S. Sabnis; *Vice-Presidents*: Dr L. A. Ramdas and Dr R. Misra; *Treasurer*: Dr B. S. Navalkar; and *Joint Secretary*: Dr T. J. Job.

At the Annual General meeting of the Indian Botanical Society held at Patna on January 1 last, the following were elected officer-bearers for 1948: *President*: Prof. A. C. Joshi; *Secretary*: Dr T. S. Mahabale; *Treasurer and Business Manager*: Dr S. P. Agharkar; *Editor-in-chief of the Journal*: Prof. G. P. Majumdar.

IT has been decided that Delhi will be the headquarter station of the South Asia Field Science Corporation of the UNESCO and Dr A. Walsky, a Hungarian geneticist, has been appointed the principal officer of the Field Science Corporation. Dr Walsky is expected to take up this appointment this month.

DR S. N. DAS GUPTA, former reader in botany, University of Lucknow, now serving with the UNESCO as one of its Counsellors for the agriculture section attended a rice conference of F.A.O. in the Phillipines in February last. On his way back to Paris, he will stay in India for a short period.

Dr Das Gupta was recently admitted to the degree of doctor of science of the University of London.

Dr. Joseph Needham, who was director of Natural Sciences Section of the UNESCO will be succeeded by Prof. Pierre Auger, a celebrated French worker on Cosmic Rays in April 1948

Prof. N. R. Dhar, Professor of Chemistry, Allahabad University, has been appointed the first Sir P. C. Ray Memorial Lecturer of the Indian Chemical Society. The lecture will be delivered on the birth anniversary of Sir P. C. Ray, on the 2nd Augu 1948 at Science College Buildings, Calcutta, wh P. C. Ray lived and worked.

Dr Tarachand, former Vice-Chancellor Allahabad University, has been appointed secretary the ministry of education, Government of India.

Mr. Humayun Kabir, formerly of the depart ment of philosophy of Calcutta University, has bee appointed deputy educational adviser to the Govern ment of India.

BOOK REVIEWS

Petroleum Resources of India—By D. N. Wadia, pp. 34. Special Publication No. XI of the Indian Association for the Cultivation of Science (Based on the Lectures delivered on the occasion of the Award of Joykissan Mookerjee Medal 1945).

At a time such as the present when the world shortage of oil is daily brouht home to all of us, and when there is active speculation about the possibilities of increasing the supply from within India, the publication of this review of the potentialities is of considerable current interest. Although the lecture was given some time back, (See Science and Culture, *10*, p. 485, 1944-45) account has been taken (as the bibliography shows) of some of the more recent publications on this subject: particularly as regards the intensive geological and geophysical surveys started in India by the large Oil Companies just before the war, and now resumed after the enforced interruption.

Mr Wadia reviews the possible oil-bearing territory of India and Pakistan, and explains the principles (which are those generally accepted in scientific oil prospecting) on which he bases his evaluation of the prospects. He reaches the conclusion that, especially considering the almost uniformly disappointing results of past prospecting, there is not very much hope of new large oilfields in the areas where exposure of the rocks allows ordinary geological principles to be applied, but that the concealed areas under alluvium may yet reveal unsuspected riches when the latest geophysical techniques (now in progress) are applied. However, unless new production is encountered in exposed structures and thus proves the existence of a petroliferous province, the neighbouring concealed areas may presumably remain doubtfully attractive. Mr Wadia also points out certain other areas which he thinks may have been relatively neglected so far.

There is so much general misapprehension of the basic facts about petroleum by those who do not happen to be specialists in that line that it is a pleasure to meet an exposition by one who has a thorough grasp of the subject. That his opinions have not merely theoretical value may be judged by the fact that the most recently discovered oilfield (Joya Mair in the Punjab) was selected by him as a favourable area as far back as 1929, at a time when drilling technique was hardly ready to make the test.

J. C.

Practical Plant Anatomy—By A. S. Foster. Published by D. Van Nostrand Co., New York (Macmillan & Co. Ltd., London) 1942. Price 14*s*. net.

A thorough understanding of a subject like plant anatomy necessitates sound practical work against the background of clear ideas in theory. This book is a suitable guide in this direction, and fulfils a definite need for the B.Sc. pass and honours students in plant anatomy of the Indian Universities. Many materials suggested for study are easily available in India, and alternatives may be found out for the rest.

Each exercise begins with an "Introduction" containing up-to-date information of the subject of study, and it attempts to effect a successful link-up between theory and practice. The author has endeavoured in his instructions for the study of materials in the practical class with the "best of modern theory and interpretation". In this respect the book is unique of its kind. Highly theoretical problems like 'stelar theory', ontogeny of various other tissues and elements, evolutionary development of vessels in seed plants etc. are admirably discussed and suitable materials are suggested for study in the laboratory. In some way, the book appears to be a companion volume of "An Introduction to Plant Aanatomy" by Eames & MacDaniels, (New York, 1925). These two books together form a complete course in plant anatomy for the beginners, and may be profitably read by the advance students as well.

Portions dealing with plant microtechnique appear to be incomplete. References to suitable literature have, however, been made for better guidance. The directions etc. at the end of each chapter are highly suggestive and the teachers may profitably use them for practical instructions with modifications as deemed necessary.

The literature cited is very helpful for both students and teachers, and will be of great value to the researchers. It appears to be quite exhaustive.

J. S.

Electronics in Industry —By George M. Chute. Published by McGraw Hill Book Company. Inc. New York, 1946. Pp. 471.

The book presents an up-to-date account of the use of vacuum tube circuits in various industrial plants. Electronics has already found new and useful application in industry. In this era of electronics the book will render much help to those who want to apply electronic devices for the operation of all kinds of electrical circuits successfully and with convenience and efficiency.

The applications described in the book are just a hint of the wide range of jobs that modern vacuum tubes can do. The limit to which electronics can be used in industrial field will be governed by the engineer's ingenuity. The book only outlines the industrial uses of the tube circuits and gives explanation of a large number of electronic equipments now serving in industrial plants.

No mathematical treatment of the problems will be found in the book and it is not at all a text-book on Radio electronics. The book gives introduction to all types of vacuum tubes including thyratrons and other soft vacuum tubes and outlines their respective behaviours. In particular, it deals with the use of the tubes in the following: (1) the control of large A.C. loads, (2) speed control of D.C. Motor, (3) control of the intensity and timing of the welding currents for the maintenance of proper and constant heat in spot welding and steam welding, (4) regulation of the voltage and speed of a D.C. and A.C. generator, (5) temperature recording, (6) high speed light relays, (7) controlling the printing and cutting of paper as it comes off large rolls (Register control), (8) Thy-Mo-Trol (Thyratron motor control), (9) Arc welding.

As a whole, the book gives us fair idea of how the use of vacuum tubes has become helpful in our everyday life other than for the transmission and reception of the radio signals. It will be interesting and useful to go through the book.

S. K. S.

The Muria and their Ghotul—By Verrier Elwin. Published by Oxford University Press, Indian Branch, 1947. (Pp. 730, including indices, glossaries and appendices). Price Rs. 25/-.

The book is the product of a very close observation of the Muria people of the Bastar State by Dr Verrier Elwin. The book is divided into two parts. Part I deals with the pattern of Muria life *i.e.*, the setting and background. Part II describes the Ghotul *i.e.*, the life of the Chelik (boys) and the Motiari (girls) in detail.

Social groups are based either upon the idea of kinship or on that of locality. But there are associations among the primitive people, where the cleavage is along other lines. The different groups may be formed upon the basis of sex, of age and some other criteria. These associations have a widespread distribution in many parts of the world and are intended on the whole for education of the youth of the tribe in its traditions and social practices. Very few of such dormitories have been studied in sufficient detail for comparison. This omission has been corrected in the case of the Murias, who have been studied by Dr Elwin. The Muria 'Ghotul', which means a village dormitory, is an institution tracing its origin from Lingo Pen, a famous cult-hero of the Gond. Here the boy and girl members, known as chelik and motiari respectively, are initiated and given special titles with graded ranks and duties till marriage. The average number of members in the dormitory is 20. The chelik and the motiari play important part in Muria socio-religious life. Ghotul is also 'the school of marriage, a training ground of the domestic virtues'. Two types of Ghotul are prevalent —(1) in the former, both chelik and motiari pair off permanently, and (2) in the later *i.e.*, in modern type, promiscuity is the practice. But the idea is not trial marriage, as few ghotul partners marry. Marriages are settled by the partners. Divorce according to custom is easy but very few cases occur, so also the infidelity of husbands and wives. Prostitution is unkown in the Muria society. Generally crime is accounted to be very low. Dr Elwin has opened up the secrets of the sex life of the Muria chelik and motiari by painting pen pictures, surpassing even what Havelock Ellis and Freud could do for primitive societies. Dr Elwin gets the opportunity of painting the sex pictures of the Muria people in the realm of reality as he happens to be a member of a tribal people—the Gond—through his own social tie.

The Muria people, as depicted by Dr Elwin, are a happy, peace-loving, hard-working people enjoying games, festivities and showing moderate artistic merits. The book can be described as a museum of ethnographic facts, illustrated by drawings, photographs and statistical data.

M. N. B.

LETTERS TO THE EDITOR

[The Editors are not responsible for the views expressed in the letters.]

TELESCOPIC FISHING SPEAR

A SPECIAL type of fishing spear, known as *Kole*, is used in some parts of lower Bengal. The specimen described in this note was collected from Narail, the easternmost Subdivision of the district of Jessore. On the east it is bounded by the river Madhumati or Gorai, which with some of its branches may be regarded as one of the largest repository of fishes in this province. Here in the seasons when the river waters are fairly clear, the *Khorsula* fish (*Mugil corsula*) is found constantly swimming on the surface of the water close to the banks. These swim with unusual swiftness.

Kole has a very long shaft made up of a number of reeds telescopically joined. The head is a small and finely sharp-pointed trident with barbed points. The entire head is only 5 cm. long and the tang is inserted into the shaft and strengthened by winding thread round the place of insertion. The barbs are on one side. It is made of smooth reeds and can be very slowly passed along the surface of the water without stirring the water. When the point is within a distance of about a foot from the fish, a sudden forcible thrust is made and one or two fish will be found impaled on the points of the trident. As the spear is to be passed along the surface of the water, it is best to use it from a low-decked boat (locally known as *Jāle-dingi*), from where the *Kole* can be conveniently held just floating on the surface of the water. To use it without a boat, one has to get down into knee-deep water and keep it in just the floating position by bending down to hold it. The operator stands either in water very near it or on the bank of a river and places on water the first section of the implement in which the trident is fixed. Next he aims at a shoal of fish and goes on increasing the length of the implement by telescoping the extra pieces one after another until it approaches very near the shoal. Then he gives the sudden push as mentioned. It is found to be used by the *Bedias*, a class of people living in boats on the rivers of Bengal and earning their livelihood by selling articles of toilet and children's playthings to the children and women folk in the remote river side villages of Bengal. Sometimes *Namasudra* boys have been found to use it. It is used either from the bank or from a small boat.

The specimen collected by the writer consists of five pieces of long reeds. Each reed is from 125 to 200 cm. in length and 1·2 to 2·5 cm. in circumference. The total length without trident is 815 cm. When telescopically joined, the total length comes down to 788·6 cm.

Young boys in the villages have sometimes been found stealthily using it in the jungle to catch birds.

M. N. BASU

Department of Anthropology,
Calcutta University,
17-11-1947.

SYNTHESIS OF *CIS-APO*-FENCHOCAMPHORIC ACID

OXIDATION of β-fencho-camphorone furnishes *cis-apo*fencho-camphoric acid, m.p. 144-145°, which can be readily isomerised to the corresponding *trans*-acid, m.p. 146-147°. Both these stereo-isomeric acids[1] have since been obtained synthetically in extremely poor yield. The method[2] is clearly unsuitable for the preparation of appreciable quantities of *cis-apo*fencho camphoric acid required in connection with another research. In the course of the following investigation, however, a satisfactory preparative method has been found out which renders *apo*fenchocamphoric acid much more readily accessible than it has hitherto previously been.

Ethyl γ-methylbutane-$\alpha\alpha\gamma$-tricarboxylate[3] on condensation with ethyl β-chloropropionate in presence of sodium ethoxide gave *ethyl* $\alpha\alpha$-*dimethylpentane-*$\alpha\gamma\gamma\epsilon$*-tetracarboxylate* as a colourless liquid, b.p. 160-161°/4 mm., which on hydrolysis with dilute hydro-chloric acid (1 : 1) yielded $\alpha\alpha$-*dimethylpentane-*$\alpha\gamma\epsilon$*-tricarboxylic* acid, m.p. 143-144°. The corresponding *tri-ethyl ester*, b.p. 148°/4 m.m. on Dieckmann-cycisation with sodium dust in the usual way afforded *ethyl 2 : 2-dimethylcyclohexan-1-one-4 : 5-dicarboxylate* as a somewhat viscous liquid, b.p. 132°/4 m.m. This on hydrolysis with hydrochloric acid readily furnished *2 : 2-dimethylcyclohexan-1-one-4-carboxylic acid*, m.p. 96-97°, which gave a crystalline *semicarbazone*, m.p. 215°. The *ethyl ester*, b.p. 110°/6 mm. on bromination in the cold, in presence of glacial acetic acid gave a liquid *bromo-derivative*, which on boiling with aqueous barium hydroxide solution[4] afforded a good yield of *2 : 2-dimethylcyclopentan-1-ol-1 : 4-dicarboxylic acid*, m.p. 202°, which could be converted into the corresponding *ethyl ester*, b.p. 128°/4 mm. Unfortunately, all efforts to prepare dehydro-*apo*fenchocamphoric acid from this were fruitless.

3 : 3-Dimethyl*cyclo*pentan-1-one-4-carboxylic acid prepared according to the methods given in the literature[5] was converted into the *ethyl ester* which formed a colourless liquid b.p. 105°/6 mm. This readily reacted at a low temperature with liquid hydrogen cyanide in presence of a few drops of a saturated solution of potassium cyanide. The crude cyano-hydrin thus obtained on digestion on the steam-bath with phosphorus oxychloride and pyridine followed by hydrolysis of the resulting *unsaturated nitrile* gave *dehydro-apofenchocamphoric* acid as a crystalline solid, m.p. 203°. This on hydrogenation in glacial acetic acid solution with platinum oxide at the room temperature gave chiefly *cis-apo*fenchocamphoric acid, m.p. 144-145°.

Ethyl αα-dimethylbutane-αβδ-tricarboxylate[6], b.p. 145°/4 mm. was allowed to react with finely powdered sodium and the resulting sodio-derivative on treatment with ethyl bromoacetate gave *ethyl 3 : 3-dimethyl - cyclopentan-2-one-3 : 4-dicarboxylate-1-acetate*, as a viscous liquid, b.p. 180-182°/4 mm. This on hydrolysis and elimination of carbon dioxide by boiling with concentrated hydrochloric acid afforded a thick liquid which was esterified, in the usual way, to give *ethyl 3 . 3-dimethylcyclopentan-2-one-4-carboxylate-1-acetate*, b.p. 165°/4 mm., having a faint terpene-like smell. The latter on reduction with amalgamated zinc and hydrochloric acid according to the method of Clemmensen furnished a gummy acid which could not be further purified.

Ethyl 3 : 3-dimethyl*cyclo*pentan-1-one-4-carboxylate was next condensed with ethyl cyanoacetate following Cope and co-workers[7] to give ethyl 4 : 4-dimethyl-3 -carbethroxy*cyclo*pentylidenecyanoacetate, b.p. 180°/4 mm. This on reduction, in the usual way, gave the corresponding *dihydro-derivative*, b.p. 168°/4 mm. which on hydrolysis with hydrochloric acid furnished 4 : 4-dimethyl-3-carboxy*cyclo*pentane-1-acetic acid, in a crystalline state, m.p. 175°. The corresponding *lead salt* on distillation, in the usual way, afforded the expected *bicyclic ketone (β-isocamphenilone)*, as a colourless liquid, b.p. 197° having a characteristic camphor like odour. The new gives a quantitative yield of *cis-apo*fenchocamphoric ketone on oxidation with potassium permanganate acid, m.p. 144-145°.

The author desires to thank Prof. J. C. Bardhan for his helpful interest throughout the progress of this investigation.

(Miss) DEBI MUKHERJI

Khaira Laboratory of Organic Chemistry,
University College of Science and Technology,
Calcutta, 3-1-1948.

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[3] Bardhan, Banerji and Bose, *J. Chem. Soc.*, 1127, 1935.
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[6] Gibson, Hariharan and Simonsen, *J. Chem. Soc.*, *108*, 3011, 1927; also Perkin and Thorpe, *ibid.*, *85*, 138, 1904.
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RAINFALL AT PATIALA

IN continuation of the previous work on the rainfall frequency at Patiala[1] and the rainfall in Patiala State[2], the annual rainfall at Patiala for the last fifty years has now been studied and the following results have been concluded :

(1) *Statistical Results.*

(*a*) Patiala gets major rainfall of the year from the monsoons which blow mainly as SE-winds in summer and NE-winds in winter.

(*b*) The mean annual rainfall is 25·85 inches.

(*c*) The major rainfall takes place in the monsoon months from July to September. The months of April and May in summer and from October to December in winter are generally very dry.

(*d*) The mean winter-rainfall (5·01″) is about one-fourth of the mean summer-rainfall (20·84″).

(*e*) The standard deviation of annual rainfall of the last 47 years is 8·84 inches, the coefficient of variability 34·20% and the mean deviation ± 6·96 inches.

(*f*) The average number of days associated with the rainfall in a year is 44 days.

(2) *General Observations*

(*a*) It has been observed that the rainfall obeys no law relating to time, though however in winter the rains start more generally in early hours of mornings than in afternoons, while in summer they set in more generally in afternoons than in mornings.

(*b*) The winter rainfall does not depend on the next or the past summer rainfall and vice-versa, but often abnormal high rainfall is followed by an abnormal low rainfall.

(*c*) The annual rainfall at Patiala mostly depends on its summer rainfall but not on its winter rainfall which is very small.

(*d*) The mean annual rainfall as well as the average number of days associated with rainfall in a year is irregularly decreasing with the lapse of years.

(e) When the number of days associated with rainfall in a year is high, the annual rainfall of that year is also very often high, but this relation is not very rigid.

(f) There is no simple periodic variation of the annual rainfall and the total number of rainy days in a year with time.

The detailed study will be published elsewhere

Physics Research Laboratory,

L. D. MAHAJAN

Mahendra College,
Patiala, 10-1-1948.

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EFFECT OF THE CAUSTIC ALKALIES IN DIFFERENTIAL STAINING OF THE POLLEN GRAIN NUCLEI

ACETO-CARMINE technique is admittedly the most useful and handy as well as an extremely simple method of rapidly securing differential staining of the nuclei, and is being extensively employed for handling expeditiously a large amount of material. I have lately been employing it for determining the number and characters of the nuclei in the mature pollen grains of the angiosperms. These by some authors[1-4] are believed to be of phylogenetic significance. Data, however, are still very meagre for putting this claim to test, or/and for formulating generalizations.

The technique, however, possesses some serious drawbacks. Often enough, it is found that the nuclei either do not take the stain at all or the differential staining is more or less vitiated by the affinity of the cytoplasm for the dye. In the pollen grains, the vegetative nucleus, *as a rule*, does not stain at all, and its presence is simply presumed.[1] It, therefore, appeared worth while devising some method of removing, by suitable pretreatment, the interference of the cytoplasm. For this purpose, techniques involving differential digestibility of the cell components by means of enzymes or other reagents have already been used[5-11] with very satisfactory results for the vegetative cells of plants, but so far as I am aware, nothing of the kind has been hitherto attempted on the pollen grains. Accordingly, it was decided to investigate the action of some of the reagents *viz.*, digestive juices, Glauber's salt, hydrochloric and other acids, etc. A preliminary account of these experiments was communicated earlier.[12] After prolonged trials, caustic alkalies—KOH and NaOH—have been found to give so far the best results, proving, indeed, *surprisingly* effective in producing the necessary contrast in many of those cases where the other reagents and the customary technique *totally* failed.

The technique is very simple. The fresh, fixed or even *dried* pollen is subjected to the action of solutions of these reagents for a couple of minutes or so (on a slide). When such pretreated grains are stained with aceto-carmine after washing,* the generative nucleus (or nuclei) readily shows up. The usually non-staining vegetative nucleus also becomes quite distinctly stained soon thereafter. Heating, which is otherwise necessary to secure and enhance the contrast, can be dispensed with in the pretreated grains, but if used, the results are better and quicker. Also after this treatment the chromatin net-work of the generative nucleus stands out more prominently defined. Prolonged action of the stain, however, causes the erewhile colourless cytoplasm to become gradually deeply stained. The contrast thus lost can, nevertheless, be restored by irrigating acetic acid until the necessary differentiation has been secured.

A very striking feature is that, with the increasing concentrations of the alkalies, including even their *syrupy* solutions, not only are the pollen grains *not* deleteriously affected but the differential staining is progressively better and more quickly produced. So far, the grains have been subjected for *twentyfour hours*(!) at room temperature to the action of such strong solution, *never* with any ill effects. No attempt has yet been made to determine the maximum period in this regard. For a given concentration, too, of the alkalies, application of heat gives quicker and better results. Effects of these and other reagents on the vegetative cells of plants are being studied.

The results here communicated were initially obtained on the pollen of *Capsicum annuum*, selected at random. Since then, they have been verified on a great variety of pollen grains. Nevertheless, there are plants whose pollen does not satisfactorily respond even to this technique. There are, however, hopeful signs that with yet another variation of the technique, now being tested, these refractory cases may also give satisfactory results.

A detailed account will be published elsewhere.

N. K. TIWARY

Botany Department,
Benares Hindu University,
12-1-1948.

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* Or treated with acetic acid to neutralize the alkali.

Statistics

An Outline of Some Modern Theories of Statistical Inference

S. N. ROY

Statistical inference is concerned with inferences about populations in terms of sample readings. In the technical sense in which it is here used a population means a mathematical expression for a functional form (involving parameters) giving the frequency distribution of a group (usually large) of individuals in respect of one or more characters or variates (which might be of any general nature). The inference based on sample readings may relate to either (*i*) form and parameters, or (*ii*) only parameters, assuming form, or (*iii*) might be of other non-parametric types. The problem might be (*a*) one of having to make the inference oneself in which case it may be broadly called estimation, or (*b*) one of having to check up some-body else's inference in which case it may be called testing of hypothesis. Everywhere it is really a question of (*i*) defining what is to be meant by an 'optimum' method, and then (*ii*) determining what that optimum could be.

The address starts by briefly touching upon the pioneering work of Karl Pearson ad his school and also of the Scandinavian school on inference relating to both form and parameters in case of uni-variate populations, (2) the work of Karl Pearson's school on measures of association between characters in case of multi-variate populations, and (3) the contributions of the same school to inferences of the non-parametric types. The address next deals with the work of Fisher on specific or point estimation of parameters (assuming the form). This work is conveniently split up into two parts: (1) certain concepts and techniques like sufficiency and maximum likelihood which, though introduced as auxiliaries, go far beyond Fisher's immediate problems, (2) Solution of Fisher's immediate problem which again breaks up into (*i*) a part involving the concepts of consistency and efficiency and depending on large sample assumptions, and (*ii*) a part involving the concept of information, which is independent of such assumptions. Neyman and Pearson's work on the general problem of testing of hypothesis is next taken up. (1) The optimum being defiend in terms of 'power' and 'bias' with respect to different alternatives to the hypothesis to be tested, the general technique of finding such an optimum is first sketched. (2) This is followed by a more detailed discussion of the parametric cases in which the hypothesis relates to the parameters, the form being assumed. This again is split into (*i*) cases where the hypothesis is specific or simple, being related to specific values of all the parameters, and (*ii*) cases where it is broad, relating to specific values of some parameters, no matter what the others might be, such an one being called a compositive hypothesis. Neyman's work on estimation of parameters (the form being assumed) by intervals (otherwise known as the theory of confidence intervals) is next taken up. This is closely related to the technique of testing of hypothesis just discussed.

It is shown that at this stage a need was felt for a theory which could define and generate optimum tests in cases where no discussion could be made by the earlier theories. The transition to Wald's theory of statistical inference is next discussed. This is following in succession by discussions on (1) Wald's large sample theory of testing of statistical hypotheses (for parametric cases) which is based on his concepts of asymptotic power and bias, (2) a theory of most and unbiassed powerful tests on an average (over all alternatives), initiated by Wald, and (3) Wald's general theory of statistical inference, in which the problems of estimation ad testing of hypothesis are each individually broadened and then fused together, and a solution is sought to be given under this general set-up.

All these are in terms of samples which are of a fixed size for any particular stochastic process. A new technique due to Wald and his school, which is known as sequential analysis, is discussed at the end. In this technique observations are taken one after another and the sample size is not supposed to be preassigned but is itself a stochastic variable, whether or not a fresh observation has to be made at any stage being dependent on what the observations taken so far have revealed. The practical end in view is the taking of either of two different alternative actions. The requirements for an 'optimum' test are next defined in terms of (1) an 'operating characteristic curve' or 'OC' curve based on a relation between the

parameters and the probability of taking under any test within the technique, either of the two alternative courses of action, and (2) the average sample number required under that test. An 'optimum' test fulfilling the requirements is actually obtained, the rounding off the discussion of this topic.

Physics

The Physics of the Bottom Layers of the Atmosphere

L. A. RAMDAS

THE "Drama of Weather" is enacted in three dimensions and for a full understanding of the various "acts" and "scenes" in this vast drama, one must indeed explore the whole atmosphere. It is usual to treat the "Troposphere", or the lower portion of the atmosphere which is the seat of most of the major weather phenomena, as a vast thermodynamic "Heat Engine" with water vapour as its "working substance". It must be emphasised, however, that equally fundamental processes are in operation continuously in the atmosphere both *below* and *above* the region of clouds. One has only to mention the regions of auroral displays and ozone production in the upper air, the role of E and F layers in radio wave propagation, cosmic rays, atmospheric electricity, terrestrial magnetism in relation to solar activity, etc., to show that the whole of our atmosphere is indeed a vast "International Open Air Laboratory" in which every department of Classical as well as Modern Physics has the fullest scope for enquiry and research.

Solar radiation, just before entering our atmosphere, has an intensity of about 2 gramme calories per square centimetre per minute The sun's surface, estimated to be at the high temperature of 6,000°A, radiates like a 'black body' at that temperature. This radiation is mostly in the visible region of the spectrum, with the maximum energy in the bluish green region (at wave length 0·5μ, where μ is equal to one thousandth part of a millimetre).

The Earth, however, is only at a mean temperature of about 300°A. The 'black body' radiation at this temperature lies in the far infrad-red region extending about about 5μ to 30μ, with the maximum energy at 10μ.

Although the greater part of solar radiation lies in the visible region, the ultra-violet radiation present in it before it enters our atmosphere is sufficient to injure living matter. Fortunately for us, nature has provided an automatic control for preventing this from happening, for, practically all the injurious ultra-violet radiation is effectively trapped by the oxygen and ozone of the uppermost layers of the atmosphere. More than half the heat radiation emitted by the earth's surface is returned to it by the atmospheric water vapour, carbon-dioxide and ozone. These components of the atmosphere absorb considerable fractions of the earth radiation in their characteristic absorption bands. The main absorption bands of water vapour occur at 5·1 to 7·9μ and at wavelengths greater than 15μ; those of CO_2 occur at 4·3μ and at 15μ; ozone has a strong absorption band centred at 10μ where water vapour itself is transparent to heat radiation.

Now each layer of the atmosphere, in turn, emits radiation in those wavelengths where it absorbs in proportion to the amount of the absorbing gas present and appropriate to its temperature, in accordance with Kirchhoff's law.

Dobson's recent observations with his new photo-electric dew-point hygrometer show that the upper atmosphere above the tropo-pause contains little or no water vapour. This, coupled with the well known dimunition with pressure of the absorption coefficient, indicates that the layers which can emit water vapour radiation towards the ground are confined to the troposphere or the first few kilometres above ground, leaving ozone as perhaps the only other agent so far as the contribution from the upper atmosphere is concerned.

Tropopause, which is the transition layer between the troposphere and the stratosphere above, is highest and coldest above the equator. In the upper stratosphere and still higher regions the effect of ozone absorption perhaps takes entire control and the temperature goes on continuously increasing with height. Our knowledge of the structure of these far away layers of the atmosphere is still far from complete.

There are various factors controlling the disposal of the solar radiation arriving at the ground surface. At the Central Agricultural Meteorological Observatory at Poona, experimental methods and techniques for actually measuring these diverse fac-

…ors by direct observation have been evolved. Direct solar radiation is measured with a solarigraph, thermal radiation from absorbing gases with a Pyrgeometer, the heat flowing towards the ground surface from below during the night with a series of soil thermometers, and the latent heat liberated at the surface when water vapour condenses at or is absorbed by the soil surface, during the evening and night, is calculated from the total gain in weight due to the water vapour absorbed.

Thus we can actually work out a 'Profit' and 'Loss' account of the heat balance at the ground surface as in the example given below for a clear day in April,—

Profit (in gramme calories)		*Loss (in gramme calories)*	
Radiation received from the sun and sunlit sky during day, after correcting for absorption factor at 84% .	655	Temperature radiation from the ground ...	950
		Convective heat loss	350
Heat radiation from the atmosphere at 0·48 gr. cals. per cm² per minute ...	691	Heat transfer by conduction (difference between loss by day and gain by night	35
Heat gain during absorption of moisture	20	Heat used up in evaporation by day ...	20
Total gain	1,366	Total loss ...	1,355

There was a small carry-over to the next day, of the order of 11 calories. It is obvious that when we work out the entire account of the disposal of incoming solar radiation we get a real insight into the orders of magnitude of the various phenomena which enter into the heat balance.

Besides discussing the problems connected with radiation and heat balance, Dr Ramdas discussed at length the special types of 'shimmering' and 'turbulence' characteristic of the air layers near the ground, their effect on the fluctuations of air temperature and explained his theory of the development of the nocturnal inversion (air layer stratified with temperature rising with height) near the ground which lies sandwiched between two layers of lapse (*i.e.*, between the shimmering layer below and the free atmosphere above).

The liability of different parts of India to phenomena like 'Floods' and 'Droughts' as indicated by the last 70 years' data was illustrated by a very striking diagram. Methods of measuring the relevant factors like evaporation from the soil, percolation, retention by the soil, etc., etc., and the role of certain salts in controlling the permeability of the soil to moisture, are under active investigation at the Central Agricultural Meteorological Observatory at Poona.

Dr Ramdas referred, in passing, to his work on the microclimates of plant communities which he hoped to present before an audience of biologists and agriculturists on a later occasion.

Zoology and Entomology

Sexual Periodicity in Birds with Special Reference to India

A. B. MISRA

THE reproductive cycles of birds have been studied by a number of investigators in temperate countries of Europe and in America. The studies which have have been in progress in India at Benares have yielded results which challenge the validity of some of the accepted views, and caution us about their general applicability to all species of birds.

The reproductive cycle of the male bird consists of two phases, one of which is progressive and the other regressive. The extent to which the interstitial cells wax and wane in number in the intertubular spaces during the progressive cycles is really remarkable. The semeniferous tubules are surrounded by innumerable interstitial cells and they are literally besieged by them.

The *tunica propria* covering the semeniferous tubules is thin and becomes breached at certain points on its wall. The interstitial and other cells lying in the intertubular spaces and at the ramparts of the tubules enter inside them through these breaches in the *tunica propria* and eventually become covered into spermatogenic cells. It is therefore obvious that the germ cells in the semeniferous tubules of the Indian birds, at least in the species investigated in India, are replenished every year with fresh re-inforcements of somatic cells (interstitial cells).

After the replenishment of the semeniferous tubules with the interestitial cells, a kind of intra-tubular selective elemination of cells takes place within them, resulting in the casting off of a number of worn out and effete cells into the medulla of the tubules.

It may thus be concluded that the hours of sunlight, muscular excercise, wakefulness, ultra-violet radiation, and to lesser degree temperature, food, rainfall and humidity and the action of the anterior lobe of the pituitary are the vital factors concerned in regulating the sexual periodicity in birds.

The primary function of the testes undoubtedly was and still is to produce germ cells. Later on, it complemented this function by producing an internal secretion which acting on the accessory reproductive structures such as the epidydimes, *ductus deferens*, seminal vesicles, prostrate glands, penis and other structures kept them in a fit condition for the onset of the reproductive season. The endocrine function of the ovary is necessary for the development and maintenance of the accessory genital organs and secondary sex characters in the female just as in the case of the male. These hormones have been isolated, crystalized and even synthesized chemically. Oestrogen is used as a collective term for all substances producing oestrous growth in vagina, uterus, mammary glands and the female secondary characters. Chemical substances like estrone from pregnancy urine, estradeole from the follicle of the ovary, equiline and relaxine and many other commercial preparations are now available in the market.

Rowan showed for the first time that light was a factor provoking reproductive activity of birds. Bissonnette showed that intensity and wave-length as well as the daily ration of light were factors concerned in promoting sexual activity. As a result of the work done on nearly twelve species of birds at Benares, it has been found that, the birds fall into certain well-defined categories because all of them do not seem to be governed by the same laws. All the birds examined by us are non-migrants and were secured from their native haunts in this locality so that they receive the same quantum of light. Light qua-light can be a potent factor only in countries where there is considerable difference between the hours of sunshine during the various seasons of the year (winter, spring, autumn and summer), but in a place like Benares the contrast between the seasons is not so sharp as in Canada, U.S.A. or in England. Therefore, it seems logical to argue that light qua-light does not play an important part in inducing sexual activity in Indian birds.

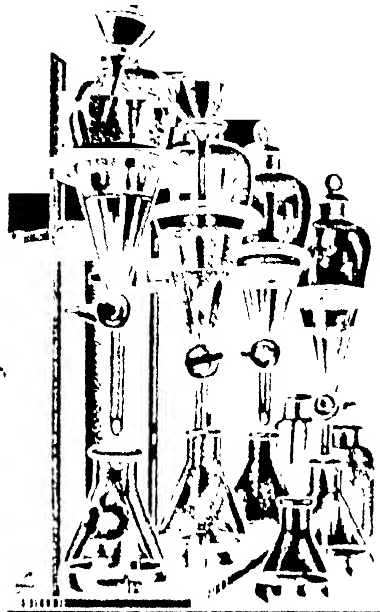
It is held by Marshall, Marshall & Bowden and Baker that ultraviolet radiation also induces periodic sexual activity in birds and nammals and increased artical dosage may even bring about precocious and untimely sexual maturity.

A higher quantum of ultraviolet light (nearly 1/5 of that in June) is available in March also. If the graph of the annual distribution of the ultra-violet light in India (Calcutta) were to be super-imposed upon the graphs of the reproduction cycles of the Indian Birds, some sort of a coincidence will be observed, but the cases of *Tyto alba* and *Bubo bubo* stand out as remarkable exceptions.

It will therefore be seen that all birds do not seem to be under the influence of the same set of factors and it looks as if there is also some kind of internal rhythm operating in them. The internal rhythm might have been induced in the birds genetically or by periodicity in the environment.

The exact role of the central and sympathetic nervous system in the activation and in the execution of sexual acts is not fully understood by us. We lack conclusive evidence as to what specific parts of the nervous system become eroticised by the internal secretions. What part the special senses play in the excitation and consummation of the sexual acts in meditating the external stimuli is also not very clear to us. It has been found by us that mitosis occurred in two species of Indian birds at all hours of the day and the night. In this respect these Indian birds differ from the English Sparrow.

An ecological complex of multiple factors seem to govern the onset and recession of the reproductive activity in birds. It would be wrong to say that this or that factor is the sole determinative concerned in the process. The process of the activation of the pituitary, its effects upon the gonads and the accessory organs of reproduction, changes in the plumage, courtship and display, nest-building and migration constitute a chain of events which are brought about by several factors whose isolated study enables us to see only a part of the picture and not the whole of it.



SCIENCE AND CULTURE

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TO DISSEMINATE THE KNOWLEDGE OF SCIENCES AND ADVOCATE THE APPLICATION OF THIS KNOWLEDGE TO A PROGRAMME OF NATIONAL WELFARE.

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SCIENCE AND CULTURE

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MACHINERIES AND SCIENTIFIC INSTRUMENTS

INDIAN industrialists and scientific men have been conscious for some time past that during the post-war years, it has been increasingly difficult to procure any machinery and scientific instruments from abroad. Consequently the prospects of industrial expansion and increased production which are now favourite subjects of talk on the part of every minister of the centre or of the provinces rouse hopes in public mind, which are difficult of fulfilment. But the custodians of state policy will do well to ascertain the extent of India's helplessness in this key industry. Since no serious measures have been contemplated to meet the situation as yet, we are pretty certain that they are blissfully ignorant of the actual state of affairs.

It is needless to emphasize the need for machineries and scientific instruments. We are conscious of it in our every day life, whenever we enter a factory, a power station, any engineering works or a scientific laboratory. It is also not difficult to realise the extent of our dependence on foreign countries in this matter. An industrialist or a scientist would do well, if he takes stock of the machinery, apparatus, and scientific instruments and appliances which he uses every day; without which his activities would be paralyzed and find out what percentage comes from foreign countries, what percentage can be procured or made in the country, and in what situation he will be placed if the foreign exports were entirely cut off. The picture will not only be not pleasant, but simply revealing.

Let us, for the sake of the lay man, give a few examples. The medical man's activities will be paralyzed if he gets no supply of clinical thermometers, stethescopes, microscopes, x-ray apparatus and surgical instruments, and dozens of other things. The colleges and research institutions require hundreds of scientific apparatus and instruments. Every power station requires, besides the big generators, and transformers, many different kinds of meters, relays, fuses. Every big industry requires, for control purposes, any number of meters, and other appliances. Even the ordinary tradesman requires fine balances, liquid measures. Railways, telegraphs, telephone services require enormous number of scientific appliances. The watch is used by almost everybody.

Leaving heavy machineries and apparatus aside, the total expenditure on annual imports of scientific apparatus may not be so imposing as on machineries, but nevertheless without their constant and steady supply, civic and industrial life would be completely paralyzed.

Most of the scientific instruments except a few balances and measures, were unknown in a paleotechnic society, say in Europe before the seventeenth century. As knowledge of science has progressed, and new activities and industries have been built on scientific knowledge, new machineries and instruments have been evolved. Naturally the manufacture of machineries and scientific instruments started in the countries of origin of these industries, and have remained there until another country, out of sheer compulsion, or through the initiative of private individuals have made efforts to make itself independent or less reliant on foreign supply. Before the first World War, the manufacture of optical apparatus like naval telescopes, microscopes, periscopes, binoculars, prisms, theodolites were virtually a monopoly of Germany, but after the experience of the first World War, the U.S.A., U.K., and Russia made great efforts and were able not only to establish the industries on a self-sufficient basis, but in some cases, were able to score improvements over German prototypes. Many other examples could be given.

Manufacture of machineries and scientific instruments have made little progress in India because while Europe was forging ahead from palaeotechnic to neotechnic age, India remained stationary. The few industries which have been working in India

during the British epoch, are almost entirely dependent on imported machinery and scientific apparatus and instruments, and the efforts made to start manufacture of machineries and instruments have not been attended with much success owing to causes which were very ably analysed by the late Dr P. N. Ghosh and his committee (vide infra). Soviet Russia found herself in a similar plight after the Revolution of 1918, and even inspite of tremendous efforts has not been able to be self-sufficient in this respect in all matters. She has still to import much heavy electrical machinery and scientific apparatus from abroad, but in many cases her success has been striking. For example, the Optical Institute at Leningrad under the late Professor Rodzdestvensky, has been not only able to produce optical glass, but work out methods for manufacture of all kinds of optical apparatus prisms, mirrors, cameras, telescopes, periscopes, etc.

The National Planning Committee whose labours are almost forgotten by the present national government had the foresight to anticipate the present difficulties, and appointed two sub-committees for the purpose (1) The Sub-Committee on manufacturing industries with Mr Ambalal Sarabhai as Chairman and Dr Nazir Ahmed as Secretary, (2) The Sub-Committee on scientific instruments with the late Dr P. N. Ghosh, Professor of Applied Physics, Calcutta University, as Chairman, and Mr G. R. Paranjpe, then Principal of the Royal Institute of Science, Bombay, as Secretary. The report of Mr Sarabhai and Dr Nazir Ahmed has been printed, but the report of Dr P. N. Ghosh and Mr Paranjpe, though ready, has not yet seen the light of the day. A Scientific Instruments Panel was started by Sir Ardeshir Dalal, Minister of Planning and Development under the Chairmanship of Professor M. N. Saha during the Wavell regime, but before the panel could start working it was abolished on the recommendation of the Advisory Planning Board.

The National Government has recently appointed a Committee under Professor G. R. Paranjpe with the limited objective of recommending measures for the reorganization of the Mathematical Instruments Office at Calcutta and a few other Government Workshops, but the terms of reference of the Committee are extremely limited, as will be seen from the extract given below:

(i) To examine the need and adequacy of the existing facilities in the Mathematical Instruments Office for the manufacture and repair of scientific instruments, having regard to the trade capacity available in India.

(ii) If existing facilities are found to be inadequate, to formulate concrete plans, both short-term and long-term, for the development of manufacture of scientific instruments and photographic, electronic and electro-acoustic equipment.

(iii) To report whether the Mathematical Instruments Office can be used as a suitable training centre for instruments makers, mechanics, etc., and if so, to draw up a training scheme.

(iv) To examine whether the Mathematical Instruments Office should continue to be run as a Government Factory, and if so, to review the terms and conditions of service of the employees there.

It will be seen that the terms of reference for the Committee are extremely limited. Three of its clauses refer only to the Mathematical Instruments Office at Calcutta, which manufactures only surveying instruments, and according to our information, has an annual outturn of Rs. 15-20 lakhs of rupees only while the total import value of instruments is in the neighbourhood of 6 to 7 crores of rupees. These figures show that a much bigger organisation than the M.I.O. is needed.

Clause (2) can be stressed to signify that the Government of India has in mind the bigger problem, and we hope that the Chairman and the members of the Committee would take that view and recommend a much bigger organisation, and the Government of India should give, on account of the urgency of the situation, very serious attention to their recommendations.

What ought to be done.

We hope the Committee will advise the Government on the necessity of bringing into existence, one or a chain of organisations which may be called "Scientific Instruments Establishments". They should have the same pattern of organisation as has been evolved, during the war, for the various wartime scientific research stations, say the TRE-station at Malvern, or various Atomic Research Establishments e.g. the British Atomic Research Establishment at Harwell. They should include, sections on Administration, Execution, Supply, Research and Development, Production and Distribution.

Supply of Raw Materials

It may be emphasized that supply of raw materials for Scientific Instruments is a very big item in the manufacture of scientific instruments. The scientific instrument maker is somewhat in the position of a tailor who has to get his clothing, his thread, buttons, sewing machines from outside before he can undertake his work. A scientific instrument maker has, in contrast to ordinary manufacturers, to get a bewildering mass of raw materials:—metals and alloys in the form of sheets, wires, tubes, rods and bars of all sizes and shapes, glasses of all kinds, timbers in different forms, minerals, ebonites, rubber preparations, jewels, adhesives, magnets, hundreds of other things in addition to workshop machinery, standardising instruments, foundry, and glassblowing

shops. He should not be asked to undertake the manufacture of any of these things, but should have them in stock, or should have a source of supply within easy reach. In a big establishment of the kind in view, a supply department keeping a big stock of the important raw materials, and capable of readily procuring others which cannot be stocked is an urgent necessity. We have mentioned this point particularly because this has a great bearing on the choice of a site for such an establishment.

Research and Development

The core of the organisation should be the Research and Development section. The need for research in the design of scientific instruments cannot be over-emphasized. The scientific instrument maker, in contrast to the manufacturer who makes only one single variety of commodities, say sugar, textiles, steel, has usually to deal with a variety of commodities all requiring different raw materials, processes, and different groups of skilled men. Above all, he has to be in touch with the latest progress in the branch of science for which he is making instruments. All this requires a very special kind of organisation—a combination of active scientists, technicians, mechanics, carpenters, glass-blowers, and foundry-men—which are not to be found in an ordinary factory or a research laboratory. The scheme should be both horizontal and vertical.

Policy

The importance of a clear-cut policy on the part of the Central Government in this matter cannot be over-emphasized. There are, at present, great difficulties in getting scientific instruments from abroad. The supplying countries before the World War II in the order of importance to India were Germany, United Kingdom, U.S.A., Japan, Italy, France, Holland, Sweden, Switzerland. Of these countries, Germany, Japan and Italy are totally out of action, and the smaller countries of Europe are overburdened with orders from the devastated countries of Europe. The United Kingdom and U. S. A. require all the instruments their factories are producing for the enormous expansion of their scientific activity during the post-war period, and the U. S. A. has put a ban on the export of scientific apparatus which can be used for atomic research.

An extract from the *Review of Scientific Instruments* of November, 1947, Volume 18 says:—

"The regulations will strengthen the existing controls on the export of equipment adapted for use in atomic energy research and production work. The present control system includes use of the powers of the Department of Commerce under the Export Control Act of 1940, and of the Department of State, as well as consultation with and advice of the manufacturers. This system was employed by the War Department's Manhattan District prior to the transfer of the Atomic Energy programme to the Commission and has been continued by the Commission.

The regulations will provide *a more effective control* over the export of specific classes of *declassified equipment* such as radiation-detection equipment, mass spectrometers, high vacuum equipment, and particle accelerators. Other items may be added from time to time".

The significance of the above ban may not be apparent from the wording. "Vacuum equipment" can be interpreted to mean all kinds of pumps, vacuum gauges. In fact we know that many orders for pumps of different kinds from India which were accepted by American manufacturers have been subsequently cancelled as a result of the above prohibition. "*Radiation Detectors*" may be interpreted to include Geiger Counters, Electroscopes, Electrometers and even wireless equipments and so on. The United Kingdom has not been so explicit, but all Indian Scientific Instruments dealers are finding great difficulty in getting anything from there. The prices have gone up from 200 to 400 per cent. Even large grants of money to the Indian Scientific Institutions cannot be of much help under such conditions, for money has lost some of its meaning in the post-war world.

The Central Government can do a lot in this matter if they exercise a strict control on such exportable material in which India is in a position of vantage *e.g.*, manganese (indispensable for alloy steel, mica (indispensable for electrical insultation), jute, tea, thorium (for atomic energy research) and beryl (source of beryllium, which is much sought after for atomic energy research). The export of these materials should be absolutely forbidden, except on a barter system, for supply of our necessities—petrol, steel, machineries, and scientific instruments.

Recommendations of the Scientific Instruments Sub-committee of the National Planning Committee

The Sub-Committee on Scientific Instruments appointed by the National Planning Committee consisted of the late Dr P. N. Ghosh, Professor of Applied Physics, Calcutta University as Chairman, and Principal G. R. Paranjype of the Royal Institute of Science, Bombay, as Secretary, and a number of other members. It made a survey of scientific instruments manufacturing industry in India which they found to be in a very elementary stage as regards variety, quantity and quality of its products, depending for the necessary raw materials, components and machine tools on foreign imports and wanting in academically trained skilled technicians. The said sub-committee made a number of recommendations for the development of

the scientific instruments industry, the more important of which are as follows:—

(1) The manufacturers of scientific instruments should co-ordinate their activities, think in terms of specialisation to avoid wasteful overlapping and unnecessary competition as well as of mass production and quality control of their products. They should follow co-operative methods of securing the necessary raw materials and components, machine tools and machineries. They should make full use of the different scientific research laboratories, standardising institutions and test houses in the country. They should secure adequate State support in matters of capital, expert technical advice, protective legislation and marketing facilities.

(2) A scheme for training apprentices in different industries should be worked out and introduced without any delay by each provincial government in close co-operation with the different manufacturers in that province.

(3) The Government should make the necessary arrangements whereby it would be possible to send large numbers of properly equipped apprentices to foreign countries and secure for them adequate training facilities and actual experience in the technique of the production of scientific instruments of all sorts and in all stages.

(4) There should be a State department of Industrial Research, which should establish a separate Scientific Instruments Committee. This should be well equipped and constantly maintained with ample up-to-date facilities in regard to Laboratory, Library, Personnel and Commercial Intelligence. It would be the business of this committee to initiate and undertake investigations in all matters pertaining to the manufacture of scientific instrument from the selection of raw materials to the production, testing and marketing of the products.

(5) The Board of Scientific and Industrial Research should interest itself in the production of the following items which are of the utmost importance to the industry of scientific instruments.

Optical glass; Special alloys for springs, magnets and resistance; Synthetic resins and ebonite; Tubes of brass and other metals; Abrasives and grinding materials.

(6) Legislation should be provided for adequate protection and preference of scientific instruments made in the country. In the transition period, imports of components and raw materials should be gradually discouraged or altogether stopped wherever possible. An assembly of parts, which builds up an instrument out of components, particularly imported, should have the second preference.

(7) The subject of Applied Physics, which is generally neglected, should be given a prominent place in all University centres and it should be studied from both the theoretical and practical point of view.

The sub-committee also recommended for the establishment of Industrial Research Laboratories and a Standards Institution, which are considered essential in the successful manufacture of scientific instruments

ATOMIC ENERGY IN FRANCE

THE leading rôle played by the U.S.A., supported to a considerable extent by the United Kingdom and Canada, in the successful realization of the atomic bomb, has so much occupied men's attention since Hiroshima, thanks to the Press and other potent instruments of mass media, that little attention and thought have been given to important developments in other countries. There was, of course, also the difficulty of free flow of information owing to inevitable war-time restrictions which continued for a considerable time even after the cessation of hostilities. Not until recently could a reliable account of the war-time atomic research in Germany, about which people everywhere had been hotly speculating all these years, reach the world public.

Meanwhile, new interest has grown around the possibility of the many and varied peaceful applications of the atomic energy. A number of countries whose aggressive role in the event of an atomic warfare is highly questionable have adopted ambitious programmes of atomic research and development. Some of them have even already given evidence of notable progress. If the future is not darkened by the much apprehended reality of an atomic armament race, the competitive efforts of these countries directed to industrial application of this new source of power will bear fruit sooner than expected.

In France, the writer had the privilege of personally coming in contact with her leading atomic scientists and research establishments. The great

energy and enthusiasm with which the scientists of this country, devastated by War, Occupation and Liberation and seething with political and economic unrest, complicated further by powerful foreign influences, have applied themselves to the task of peaceful developments of atomic energy, is undoubtedly an inspiring example. An account on the recent developments in atomic energy research in France may be of some interest to our readers now that India has also adopted a bold programme of developing her atomic power resources.

Research in Nuclear Fission before the Military Collapse

The pioneering contributions of the French in the field of atomic and nuclear research are well-known. Since the discovery of radio-activity by Henri Becquerel and of radio-active elements by Pierre and Marie Curie, the French have developed a long and unrivalled tradition in atomic research, which, it is fair to acknowledge, was largely responsible for her subsequent notable contributions in the thirties and after. The brilliant work of Joliot-Curies—husband and wife—which culminated in the discovery of artificial radio-activity, should be viewed against the background of this tradition. The discovery of uranium fission by Hahn and Strassmann is a direct consequence of the work on artificial radio-activity, and, as Professor Joliot has recently observed,* it is very probable that the work of Irène Curie and Savitch† had a happy influence on the work of the two German chemists.

The work of Hahn and Strassman at Kaiser Wilhelm Institute was followed with great interest in France as elsewhere. The confirmation of nuclear fission, and the experimental proof of the release of considerable energy were simultaneously worked out by Professor Joliot in Paris and by Dr Frisch in Copenhagen. Shortly after, Joliot and his co-workers, Halban and Kowarski, at the collège de France, were able to show experimentally that more than one neutron was emitted during the fission of uranium nucleus and that these neutrons could initiate a chain reaction. This was a very important discovery as it forshadowed the explosive possibility of atomic energy and its eventual military utilization.

In the Collège de France, all this was carried out during the first half of 1939, and by September of the same year, great advances were made on the solution of the many fundamental problems associated with the fission. Then came the War. But the work continued, mostly in secret, until the final military collapse of France. During the period, up to June (1940) the French scientists were preoccupied with securing essential raw materials for the study of the most exact conditions necessary for the development and control of the chain reaction. The most important of this *procurement drive* was the purchase by the French Government of the world's stock of 180 litres of heavy water held by Norway and its secret shipment to Paris. Monsieur Raoul Dautry, then Minister of Armaments and now General Administrator of the Atomic Energy Commissariat, was primarily responsible for arranging this historic travel of heavy water.

The experimental work first started in the Collège de France continued till May 1940, when the invasion of Holland and Belgium obliged the French scientists connected with atomic research to move, with the experimental materials, to a villa in Clermont Ferrand. The precious stock of heavy water was transferred to a cell of *Riom prison*.

The military collapse of France in June 1940 rendered impossible any further progress in nuclear research. By common consent, it was decided that Halban and Kowarski should leave France with the stock of heavy water and other vital documents and join the Allies in England. They embarked at Bordeaux on June 19, 1940, carrying an order of mission, and joined the British research workers at the Cavendish Laboratory, Cambridge. A little later, the French group was joined by Monsieur Jules Guéron, the chemist and one of the most important workers in the team.*

After the Libération

The atomic research was actively resumed after the Liberation with Frédéric Joliot, Irène Curie, Pierre Auger and Francis Perrin, as the principal figures. The explosion of the atomic bombs in Hiroshima and Nagasaki, greatly accelerated this research, and General de Gaulle, President of the Provisional Government asked the Minister of National Education and the Minister of Finances to prepare and submit, in co-operation with the atomic scientists, a plan for a Government organization for the development of atomic energy in France. In its terms of reference, the Government explained its interest in the atomic development project, as follows:

(1) To raise the standard of research in pure and applied sciences to a state such as guarantees original

* *Atomes*, No. 15—June, 1947.

† Savitch is a Yugo-slavian, and is Prof. of Chemistry at the Belgrade University.

* While Americans and the English were making supreme efforts for military use of Atomic Energy, the French refugee scientists were allowed to contribute their own share. The French Savants Halban, Kowarski, Pierre Auger, Gueron, Goldschmidt along with Pontecorvo—an Italian Research worker who had worked for several years in the laboratory of Nuclear-Chemistry in the Collège de France—were given important functions in the Anglo-Canadian project on Atomic Energy Research in the Chalk River Station, West of Toronto.

contribution to the universal development of atomic science and its peaceful applications.

(2) To create a group of French scientists and engineers fully conversant with the latest facts and fundamental ideas in the field of nuclear chain reactions and ready and capable of utilizing such facts or ideas as soon as discovered or developed.

(3) To make available to the laboratories of physics, chemistry, biology and medicine new instruments and apparatus for producing isotopes on a large scale for indicator studies as well as for radio-therapy.

(4) To develop atomic power as a supplement for power from coal and running water for industrial development.

The Atomic Energy Commissariat

A Plan was submitted and, by the Decree of October 30, 1945, the Provisional Government of the French Republic announced the creation of the Atomic Energy Commission (Le Commissariat à l'Energie Atomique). The following is the text of the Decree published in the *Journal Official*, October 31, 1945.

Article 1. There is instituted, under the name Atomic Energy Commissariat an establishment, scientific, technical and industrial in character, endowed with civil personality as well as administrative and financial autonomy and placed under the authority and control of the President of the Provisional Government.

The Atomic Commissariat shall:

Pursue scientific and technical research with a view towards utilization of atomic energy in the diverse fields of science, industry and national defence;

Study the measures necessary to assure protection of persons and property against the destructive effects of atomic energy;

Organize and control, in accord with the interested ministerial departments, the prospecting and exploitation of deposits of necessary raw materials;

Realize at the industrial scale the production of energy of atomic origin;

Furnish to the Government all information concerning atomic energy and its applications and, particularly, enlighten it in the negotiation of international accords;

And, in general, take all measures useful to place France in a position to benefit from the developments of that branch of science.

It will dispose, for the execution of its mission and according to the rules laid down for its functioning, of the powers actually granted to the interested Ministers.

Article 2. The Atomic Energy Commissariat is administered by a Committee which includes, under the chairmanship of the President of the Provisional Government;

A High Commissioner of Atomic Energy, chosen from the person qualified by their work relative to Atomic Energy;

A General Administrator delegated by the Government;

Three persons qualified by their work relative to the atomic energy;

The president of the National Defence Research Co-ordination Committee;

The members of the committee other than the ex-officio member will be named by decree of the Council of Ministers, on the report of the Minister of National Education and the Minister of Industrial Production and, as concerns the General Administrator, with the counter-seal of the Minister of Finances.

Article 3. The High Commissioner will assure the scientific and technical direction of the establishment.

The General Administrator, delegated by the Government, is charged with its administrative and financial direction.

The Commissariat is represented on the National level and in the international negotiations by the High Commissioner and the General Administrator acting jointly or separately; they will fix together the conditions of the industrial realizations of the Commissariat; they will be the counsellors of the Government on all questions relative to Atomic Energy.

Article 4. In order to facilitate the solution of questions interesting the Commissariat, the President of the Provisional Government, when there is occasion, will bring together in an inter-ministerial committee the ministers interested in each particular case.

The General Administrator, delegate of the Government and the High Commissioner of Atomic Energy will have access to said committee.

Article 5. The Atomic Energy Commissariat is authorized to assure its financial management and to keep its accounts according to commercial usage.

It is subject to a financial control the rules of which will be determined by the rules of public administration referred to in Article 8 below.

It is expected from the financial control provided for in the decree of October 25, 1935 . . . . , by the decree of October 30, 1935 . . . , and by the ordinance of November 13, 1944.

The Commissariat cannot resort to public loans without the previous approval of the Minister of Finances.

Article 6. The High Commissioner and the General Administrator will address to the President of the Provisional Government and to the Minister of Finances an annual report on the activity and the management of the Commissariat.

The General Administrator will submit to the approval of the President of the Provisional Government and of the Minister of Finances an annual budget and, if there is occasion, supplementary statements in the course of the year; these statements will be communicated to the Minister of National Education and the Minister of Industrial Production.

Article 7. The Atomic Energy Commissariat will receive, as an initial appropriation, an extraordinary subvention of 500 million francs which will be charged to a special account of the Treasury.

The sums necessary, to the accomplishment of its mission will be included each year in the State's budget.

It is, in addition, empowered to receive all public subventions as well as all gifts or legacies in money or in property.

Article 8. A rule of public administration taken on the report of the Minister of National Education and the Minister of Finance will fix the conditions of application of the present ordinance and will determine particularly the administrative and financial functioning of the establishment as well as the respective functions of the High Commissioner, the General Administrator and the Committee.

Article 9. This ordinance will be published in the Official Journal of the French Republic and will be executed as law.

Thus, directly under the Prime Minister (Président du Conseil), the Atomic Energy Commissariat

is headed by the High Commissioner who is Professor Frédéric Joliot-Curie. M. Reoul Dautry has been delegated by the Government to act as the General Administrator. The other members of the Commissariat are:

- Madame Irène Joliot-Curie, Director of the Insitut du Radium.
- Professor Pierre Auger, Director of Superior Teaching, Ministry of National Education.
- Professor Francis Perrin, Professor of Physics, Collége de France.
- General Dassault, Grand Chancellor of the Legion of Honour and President of the Scientific Committee of National Defence.
- Professor Léon Denivelle, Professor at the Conservatoire National des Arts et Métiers (Secretary-General).

The High Commissioner, the Administrator General and the four officials—more appropriately Commissioners, and the Secretary-General constitute the Committee for Atomic Energy which takes all the decisions and whose meetings are presided over by the Prime Minister.

The Scientific Committee: The Commissariat has constituted a Scientific Committee to prepare and recommend plans of research to the Atomic Energy Commission. The Scientific Committee is composed of the High Commissioner, the three Scientific Commissioners, the Secretary-General and Drs Lew Kowarski, Jules Guéron and Bertrand Goldschmidt. The active part played by the three scientists in atomic research in France before her capitulation and later on in Great Britain has already been referred to. Dr Kowarski is the Director of the Scientific Services, while Drs Guéron and Goldschmidt are respectively the chiefs of services for General Chemistry and Extractive Chemistry.

The Scientific Committee of the Commissariat is represented on a number of National Commissions concerning national defence, hygiene, industrial production and medical legislation. In general, this Committee acts as the liaison with the various organs of the Government, which are interested in some way or other in the development of atomic energy.

The Advisory Committee: Furthermore, a committee of eight scientists of the highest distinction M Borel, Louis de Broglie, Maurice de Broglie, Cacquot, Cotton, Délépine, Lebeau and Roussy—has been set up to advise the Committee for Atomic Energy on all scientific matters. Besides, scientists from many fields of speciality serve the Commissariat in an advisory capacity. Thus, on problems of biology and medicine, the Scientific Committee is advised by Monsieur Lacassagne and M. Courrier, of the Institut du Radium, biophysical branch.

WORK OF THE COMMISSARIAT

Technical Personnel: As provided for in the Decree, the Commissariat started with an initial budget of 500 million francs, *i.e.*, a little over one million sterling.* Its first efforts were directed to the training of the research workers capable of handling technical problems associated with atomic energy development. For this purpose, the existing research laboratories were utilized as far as possible from the inception of the Commissariat. Thus facilities for research were provided for young graduates fresh from the Universities in the Laboratoire Curie of the *Institut du Radium*,† the Nuclear Chemistry laboratories of the Collège de France, and the physics laboratory of the Ecole Normale Supérieure. The nuclear chemistry laboratory of the Collège de France was equipped, among other things, with a cyclotron which made possible important studies in nuclear chemistry and physics. The physics laboratory of the Ecole Normale specialized in counter-technique and also recently undertook to construct an apparatus for separating isotopes. Mention should also be made of the *Laboratoric de Synthèse Atomique* (Ivry) under the *Centre National de la Recherche Scientifique* (*CNRS*)‡ which had well-equipped laboratories for research in the acceleration of protons and deuterons. The mineralogical laboratory of the Museum provided excellent facilities for research in uranium minerals. These laboratories with long and well established tradition in research no doubt greatly contributed to the nation's store of trained research personnel for responsible position in the atomic energy project. But the need for scientists with such specialized training remains even now so great and overwhelming that for many years to come the personnel problem will be a continuous source of anxiety to those responsible for the success of the Commissariat.

FORT OF CHATILLON

The fort of Chatillon which houses the Atomic Energy Establishment of France is situated on the outskirts of Paris (about 15 km.) on a spur dominating Sceaux, Fontenay-aux-Roses Robinson.

The military administration constructed in 1875 on this place halls covering an area of 2,000 metres square buried under several metres of earth, joined

* £1=480 francs: this statement is however no longer valid on account of the recent devaluation of the franc, according to which £1=864 francs.

† Laboratorie Curie, Institut du Radium is built on the site where Pierre and Marie Curie discovered Radium in 1898. The present director is Madame Irene Joliot-Curie.

‡ Centrale Nationale de Recherche Scientifique (C. N. R. S.) corresponds to the Department of Scientific and Industrial Research in Great Britain, or Council of Scientific and Industrial Research in India.

by long corridors, and opening to the air through vaults. They may be regarded as beehive cells set on an artificial earthen hill. A wide and deep mote used to cut off the place from the external world

Having different destinies for three quarters of a century, of which the chief one was that it gave rheumatism to a large number of young military recruits, this hillock was finally made over to the Atomic Energy Commission at the beginning of 1946. It was the place where French collaborators were shot after Liberation. Under the united effort of certain resolute men, the aspect of the whole fort is being changed. At the present time, a year and half after the beginning of the work the various halls which were sombre and humid have developed into animated factories full of life, packed with modern machines while within the illuminated laboratories scientific workers, technicians wearing white blouses are carrying on the work of assembling complicated machineries. Other structures are now beginning to raise their heads on the ground outside the mound which houses the beehive cells, while the wide mote is serving as the promenade for police agents for keeping out curious onlookers. A large number of engineers, scientists and technicians are assembled in the Chatillon Laboratory

It was planned to erect the first pile of graphite of 1,000 k.w. power by the end of 1948. During the war the French scholars were unable to take part actively in the development of new technique not only of Atomic Energy Research but also of Radar development. The post-war condition have made it very difficult for the French to procure scientific apparatus from any other country. The Atomic Energy Station at Chatillon is not only a place of investigation, but is also a production factory for large scale manufacture of scientific apparatus needed for the work, e.g., Vacuum equipments, radiation detectors like G-M counters, ionisation chambers, safety apparatus against radiation hazards, sealing circuits and also apparatus for the field exploration of Uraniferous minerals. The French AEC has been fortunate enough to get from their Government the choice of workshop equipment, and materials—lathes, milling machines, shaping machines, up-to-date tools, etc., left by the Germans all over France, which they have now assembled and set up for production work.

At present the Fort of Chatillon is the centre of nuclear research bearing on the development of atomic energy. It is now planned to build much bigger laboratories and research establishments on the plateau of Saclay, about 15 miles from Paris, which will be in future the most active centre of applied nuclear research. The plan proposes to equip the Centre at Saclay with cyclotrons, betatrons and one or more atomic piles. According to the latest reports issued by the Commissariat, the site having an area of over one hundred acres has already been acquired, and detailed plans of construction are under study.

F. Joliot-curie, the high Commissioner for Atomic Energy, remarks in an article published in "Atomes, June, 1947" -

> "We find ourselves at the dawn of the atomic age very nearly in the same position as the first man who produced the fire. The fire was first used for cooking food, for heating, for lighting but these people could not imagine that one day fire would be used for steam engines, locomotives, turbines and for central heating."

Professor Joliot also discussed the various post-war difficulties that stand in the way of promotion of atomic energy researches:

> "Another deplorable consequence of the atomic bomb was the decision taken by the U. S Government to keep secret certain results of researches on Nuclear Physics carried out during the war The secrecy in the matter of fundamental research presents evident and considerable danger and retards the development of science. Secrecy in scientific publication retards production of original work and arrests the course of progress. It will create the race to armament war. On account of ignorance of what your neighbour is doing, every country will think that it has found the decisive arm, and will be forced to create the most terrible armaments.
>
> We cannot form a picture of the actual situation of the Atomic Research in our country, without noticing that the principal Uranium mines which have been so far exploited for furnishing the metal necessary for the large scale work are to be found in Canada and Belgian Congo. The last one belongs to a private company (Union Miniere du Haut Katanga) It appears 'That during the war thousands of tons of this precious mineral, pitch blende, have gone to the United States on account of an agreement reached during the war. On account of the common interest which unites France with her neighbour Belgium it is essential that we should get sufficient supply of this mineral from Belgian Congo to meet the demands of our own experiments. Whether we can arrive at an agreement or not, France should try to prospect and find out uraniferous mineral within her own domain'."

Raw Materials: The success of the project depends on the reasonable supply of the fissionable materials such as uranium, and also on that of the moderator materials such as graphite, heavy water. France is not favourably situated with regard to the supply of these raw materials. The Commissariat is therefore at present mainly concerned with the prospection for uranium bearing minerals. As already referred to, young scientists have been trained at the Institut du Radium, the Mineralogical Laboratory of the Museum and some other institutions in the method of prospecting radio-active minerals. A team of 60 prospectors are now in the field, which recently succeeded in discovering an important source in Autun. At Le Bouchet, about 30 miles from Paris, a plant has been installed for the purification of uranium salts. Its present capacity is reported to be about 100 kg. per day. The Government have also entered into contracts with some French and foreign

...s for the supply of essential raw materials for ...derator.

In conclusion, I would like to quote the following significant statement made in June 25, 1946 by Mr Parodi, Chief of the French Delegation to the Atomic Energy Commission :

"I am authorized to say that the aims and purposes which the French Government have assigned to the work of her scientists and technicians are purely peaceful. Our wish is that all the other nations of the world should do likewise as soon as possible and it is with this end in view that France will promptly submit to such rules as will be considered best and adopted by the United Nations as a guarantee for the international control of Atomic Energy. Within the framework of this international organization that our Commission is charged to institute, France will contribute, with all her intellectual and material strength, to the application, not dangerous but useful and beneficial, of this energy."*

S. S.

APPENDIX

DECREE OF 5 APRIL, 1946 (NO. 46-614)

Relative to the exploitation of substances useful to research and projects concerning atomic energy in the territories under the authority of the Minister of Overseas France other than the Antilles and Réunion (*Journal Offic. iel.* April 7, 1946, p. 2904).

The President of the Provisional Government of the Republic

On the report of the Minister of National Economy, Minister of Finance, and Minister of Overseas France;

In consideration of the law of November 2, 1945 relative to the provisional organization of public powers;

In consideration of Article 18 of the senatus-consulte of May 3, 1854;

In consideration of the ordinance of October 18, 1945 (October 30, 1945) instituting an Atomic Energy Commissariat;

In consideration of the proposals of the Atomic Energy Committee;

Decrees :

Article 1 In the territories under the authority of the Minister of Overseas France, other than the Antilles and Réunion, the State reserves to itself, under the conditions fixed by the present decree, the new rights of research and exploitation of minerals of substances useful to research and projects concerning atomic energy.

The list of these substances is established by joint order of the President of the Provisional Government, acting as president of the Atomic Energy Committee and of the Minister of Overseas France; it can be modified by the same form.

After publication of the present decree in the Official Journal of the French Republic, decrees granting licences for research, licences for exploitation or concession to public or private persons of the minerals referred to in the first paragraph of this article will be made on suitable advice of the Atomic Energy Committee.

The foregoing dispositions are applicable to mixed minerals. If the existence of a substance figuring in the order referred to in the second paragraph of this article is discovered in the exploitation of a concession granted for other substances, the manner of their exploitation will be regulated by joint decision of the President of the Government and the Minister of Overseas France.

Article 2. During a period of three years from the date of publication of this decree, the State can purchase, by way of expropriation, existing mineral rights relating to substances within the scope of the preceding article.

The deciding of purchase will be taken jointly by the President of the Provincial Government, acting as president of the Atomic Energy Committee, and the Minister of Overseas France.

Article 3. In the absence of an agreement reached within a period of three months from the notification of the decision to purchase, the indemnity of appropriation will be calculated in accordance with the value of the rights purchased, considering only the loss resulting from the eviction and without the possibility of any benefit resulting to the former owner.

It will be fixed by two arbitrators designated, one by the Administrator General, delegated by the Government to the Atomic Energy Commission, the other by the owner. If the latter fails to designate his arbitrator within fifteen days of the summons which will have been served upon him to that effect, the designation will be proceeded with by ordinance rendered on request by the President of the Civil Tribunal of the Seine.

The two arbitrators will decide within three months of their designation; this period can be extended by the parties.

If they do not agree on the idemnity, the two arbitrators will designate a third arbitrator.

If they do not agree on that designation, it will be made at the request of the party which first asks it by the vice-president of the Council of State.

The third arbitrator will decide within one month of his designation.

The arbitrators will not be required to observe forms of procedure.

The arbitral sentence will be registered without charge and vested with the ordinance of exequatur by the first president of the Court of Appeal of Paris.

The parties will be notified of it through the Administrator of Atomic Energy Committee and it can be made the subject of an appeal to the Council of State.

The Atomic Energy Commissariat will have the power to take possession of the establishment and to exercise the expropriated rights from notification of the decision of purchase, provided that it first proceed to make a contradictory inventory.

Article 4. The indemnity of expropriation will be paid within a month of the signification of the arbitral decision and will bear interest at the legal rate in commercial matters, from the notification of the decision of purchase.

Article 5. In the territories subject to the authority of the Minister of Overseas France other than the Antilles and Réunion, anyone in possession, at the date of publication of this decree, of minerals or products useful to

* "Je suis autorisé à dire que les buts que le Gouvernement français a assignés aux recherches de ses savants et de ses techniciens sont purement pacifiques. Notre voeu est que toutes les nations du monde fassent de même le plus tôt possible et c'est avec empressement qu'à cette fin la France se soumettra aux règles qui seront jugées les meilleures, dès qu'elles seront adoptées par les Nations Unies, pour assurer dans le monde entier le contrôle de l'énergie atomique. C'est de toutes ses forces intellectuelles et materielles qu'elle contribuera aux applications non dangereuses mais utiles et bienfaisantes de cette energie, dans le cadre de l'organisation internationale que notre Commission est chargée d'instituer."

research and projects concerning Atomic Energy, must declare them to the Chief of the Service of Mines of the territory.

The list of these minerals or products is established by joint order of the President of the Provisional Government, acting as president of the Atomic Energy Committee and of the Minister of Overseas France, it can be modified in the same form.

Subject to the execution of contracts concluded prior to the publication of this decree and which must be justified, transactions relating to the minerals or substances, declared or to be produced, are submitted to the authorization of the Chief of Service of Mines acting according to the instructions of the Atomic Energy Committee. The State can make itself the purchaser. The purchase price will be determinated each year in each territory by an order of the Chief of the territory, made on the proposition of the Chief of the Service of Mines.

Article 6. The rights conferred on the State by this decree will be exercised by the Atomic Energy Committee, which can substitute for itself any public or private person.

Article 7. The Guard of Seals, Minister of Justice, Minister of National Economy, Minister of Finances and the Minister of Overseas France are charged, each one in that which concerns him, with the execution of this decree, which will be published in the Official Journal of the French Republic.

LIST OF MINERALS SUBJECT TO DISPOSITIONS OF ARTICLE 1 OF DECREE 46-614 OF 5 APRIL 1946

The President of the Provisional Government of the Republic, President of the Atomic Energy Committee, and the Minister of Overseas France

. . . .

On the proposition of the Atomic Energy Committee,

Order :

Article 1. By application of the Article 1 of the Decree of April 5, 1946, there are reserved to the State in the territories under the authority of the Minister of Overseas France, other than the Antilles and Réunion, the rights of research and explotation concerning the minerals uranium and thorium.

Article 2. The Minister of Overseas France, the High Commissioner of Atomic Energy and the General Administrator delegated by the Government to the Atomic Energy Committee are charged, each one in that which concerns him, with the execution of this order.

LIST OF MINERALS OR PRODUCTS SUBJECT TO DISPOSITIONS OF ARTICLE 5 OF DECREE NO. 46-614 OF 5 APRIL 1946

The President of the Provisional Government of the Republic, President of the Atomic Energy Committee, and the Minister of Overseas France.

. . . .

On the proposition of the Atomic Energy Committee,

Order .

Article 1. In the territories under the authority of the Minister of Overseas France, other than the Antilles and Réunion, the minerals of uranium, thorium and beryllium, both these metals themselves and their compounds, are placed under the control instituted by Article 5 of the decree of April 5, 1946.

Article 2. The Minister of Overseas France, the High Commissioner of Atomic Energy and the General Administrator delegated by the Government to the Atomic Energy Committee are charged, each one in that which concerns him, with the execution of this order.

POROUS GLASS IN FILTRATION PROCESSES

B. J. RAO AND Y. P. VARSHNEY

CENTRAL GLASS AND CERAMIC RESEARCH INSTITUTE, JADABPUR, CALCUTTA

THE technique of filtration in present-day life and industry has reached the proportions of a distinct branch of science. In most of our activities, scientific, industrial and domestic, filtration finds application in one form or other. It is usually taken to mean passing a liquid through a filtering medium like cloth. But a more apt definition of filtration would be that it is a process whereby from a suspension of one or more components in a liquid or gas, the suspended matter can be separated. This is usually done by passing the suspension through a filtering medium capable of arresting the suspended matter while allowing the fluid in which the suspension is held to pass through. The filtering medium has to be selected to suit the nature of the suspension, since the success and rate of filtration depend on a proper choice.

The usual types of suspensions met with are: (*a*) Solid suspension in liquids, (*b*) Solid suspension in gases, (*c*) Liquid suspension in liquids and (*d*) Liquid suspension in gases, but in each class the conditions may vary widely according to characteristics and particle-size of the suspended matter and the characteristics of the fluid in which such suspension is held. Another important factor is the quantity of material to be handled in the filtration process. If this is large, it may necessitate simply an increase in the area of the filtering medium or a greater rate of

tration may be more economically obtained by the application of pressure above the filter *i.e.*, at the feeding or by the application of vacuum on the lower or discharge end of the filter. Thus under different conditions different techniques may have to be followed. For instance, in many cases small quantities of crystals or precipitates, suspended in large quantities of liquids, cannot conveniently be filtered through a funnel filter in the ordinary way. Recourse is here taken to the technique of suction filtration. Filtering mantles (porous) are dipped into the supernatant liquor which is sucked out leaving the crystals or the precipitates in the tank. Volatile liquids like ether and petrol are filtered by forcing under pressure through a filter. Minute bodies like bacteria and fine precipitates are filtered by vacuum filtration on account of the high resistance offered by the very minute pores (of the order of 5μ to 15μ) of the filtering medium. Materials like rosin, wax and viscous substances such as glycerine, castor oil, etc., need filtration at high temperature.

Processes of Filtration

Thus the various processes of filtration can be classed as below:

(*a*) Normal filtration at atmospheric pressure,
(*b*) Pressure filtration,
(*c*) Vacuum or suction filtration,
(*d*) Filtration at controlled temperature, and
(*e*) Microfiltration.

In each of the above classes of filtration depending on the nature of materials to be filtered, the chief factor which governs filtration is the nature and type of the filtering medium, and under different conditions it may be required to have specific properties to suit those conditions. Pressure and vacuum filtrations, for instance, demand rigidity and strength in the filter in order to withstand the difference in pressures on either side of the filter (*i.e.*, the filtering medium). High temperature filtration demands resistance to heat, in the filter. Again, acid solutions cannot be filtered through wire gauze filters and an acid resistant filter is necessary. Further, practical details of working and manipulative convenience may necessitate some other properties in the filter. Microfilters must be made of definite shapes and sizes according to need. Research work needs filters of various porosities, and pores of known diameters. Thus, the nature of the material to be filtered, the technique followed for filtration and the manipulating conveniences, all make exacting demands on the properties of the filters and consequently on the selection of material with which the filter is made and the process of its manufacture. It is not intended here to give a comparative account in detail of the different techniques of manufacture of various types of filters but a brief reference to the manufacturing techniques of glass filters and the varied uses to which they can be put is made. The following chart showing the important types of filters commonly used and some of their special properties will be of interest.

Glass as Filtering Medium

Of all filtering media,—as far as the variety of uses to which they can be put is concerned,—perhaps there is none which can find wider application than glass and porcelain filters. The noticeable property of such filters is their resistance to chemical action, a property which none of the other filtering materials possess. As such, glass and porcelain filters dominate the scientific field and find very important applications in industrial work. This, however, should not be taken to imply that other filtering materials are less important, as in their respective fields they may be equally indispensable. Flexible filters like canvas and leather for instance, are indispensable in filter presses; glass and porcelain filters, though they can be used to do the filtration with a different technique, cannot displace them. Even amongst the two of them, glass possesses certain qualities which give it precedence over porcelain. The most important of all features associated with glass is its transparency which permits observation during filtration and the importance of this in scientific work cannot be exaggerated. It has also the advantage of greater working convenience inasmuch as shaped sintered glass filters can be easily fitted and sealed in the requisite glass containers. This is not so easy in the case of porcelain filters.

The possibility of controlling the pore size in order to manufacture filters of any desired pore diameter and of uniform quality, as for instance in the manufacture of bacteriological filters, is another feature which gives glass filters a definite superiority over porcelain ones. Again there are certain applications in which porcelain cannot replace glass. Large scale filtration of hot industrial gases and dust laden air in factories where high porosity with extremely fine pores such as to allow comparatively free flow without undue obstruction is desired, is an instance where the fibre glass filter is definitely superior to porous porcelain which can only be made in blocks.

A detailed account of the process of manufacture, the different types and properties of porous glass filters, has appeared elsewhere. According to the process developed in the laboratories of the Council of Scientific and Industrial Research, glass filters were made from glass powders obtained by grinding glass, refining and grading according to the size of the granules, mixing the various grades of glass powders separately with a binder to the consistency of a paste,

S. No	Types of Filters	Special Properties	Common Uses	Remarks.
1.	*Paper filters* ..	Cheap, light, handy, flexible (Special types ashless)	Lab. filtration, Prod. gas testing units (gas filtration), etc.	Combustible, weak, destroyed by conc. acid and alkali suit only for small operations.
2.	*Fibre filters*			
	(a) Cotton	Sanitary filtration of gases to be inhaled, free flow, cheap, flexible	Masks, Lab. gas filtration, clarification of oils	Not resistant to heat and chemicals, weak.
	(b) Silk	do	do.	do
	(c) Wool ..	do.	do	do.
	(d) Coir ..	Cheap, free flow, suited for large scale operation.	Industrial filtration of Producer gas.	
	(e) Asbestos ..	Heat resistant, chemically resistant to liquids and hot dry gases	Catalyst carrier in industrial plants (e.g., SO_3), Seitz Bacteriological filter.	Weak, becomes pasty when wet
3.	*Textile filters*			
	(a) Cloth (cotton)	Clean, flexible, strong, light, can be twisted	Domestic uses, collecting industrial dusts (e.g., silica powder)	Destroyed by heat and chemicals.
	(b) ,, (Silk) .	Clean, flexible, stronger and finer than cotton cloth.	do	do.
	(c) Felt	Pads suitable for tightening between rims		do
	(d) Canvas ..	Flexible, resists high pressures.	Filter press, soap industry, ceramic and oil industries	do.
4	*Metal filters*			
	(a) Wire gauze and net metallic bar screens and gratings.	Heat and electrical conductivity, strength, heat resistance, can be soldered or welded to metal containers or built in masonry work, free flow.	Seives, domestic filters, fuel oil filters, electron filters	Reactive to chemicals.
	(b) Perforated sheet or punched plate .	do	do	do.
	(c) Sintered, porous metal .	Resistant to mechanical shock, rigid, conduct heat and electricity.	Vacuum filtration, linings of liquid gas cylinders (e.g., liquid chlorine)	Reactive to chemicals, subject to rust and oxidation
5.	*Granule filters or filter beds*			
	(a) Sand, quartz or silica powder	Large scale water filtration	City water supply	Difficulty of operation with loose granules, only for large scale filtration
	(b) Charcoal .	Clarification.	City water supply, also for absorption of gases, e.g., gas masks.	Combustible
	(c) Anthracite ..	do	City water supply.	
	(d) Carborundum powder .	Resists high temperatures, neutral	Neutral ultrafiltration.	Costly.
	(e) Diatomaceous earth .	Extremely fine, arrests bacteria	Large scale fine filtration, bacteriological filtration	Loose granules difficult to manage, difficult to manufacture in desired shapes.
6	*Membrane filters.*			
	(a) Animal membrane ..	High "Pore Volume", stretching strength coupled with flexibility, extremely fine pools for ultrafiltration.	Ultrafiltration, bacteriological filtration, osmotic pressure experiments in research laboratories.	Difficult to fix in a container, destroyed by acids, alkalies and heat.
	(b) Chamois leather ..	Stretching strength, fineness of pores, flexibility.	Thin fuel oil filtration, filtration of ceramic slurries, filter presses	Destroyed by acids and heat
7	*Ceramic filters.*			
	(a) Perforated ..	Clean, acid and chemical resistant, suited to mass production, wide application, rigid, non-inflammable, can be made in special shape	Laboratory filtering approaching Buchner funnels, Gooch crucibles, filter mantles, semi-bacterial filters, domestic (drinking water) filters.	Ratio of pore volume to material is smaller than in glass, opaque, difficulty of manipulation in the manufacture of scientific ware, difficult to clean on acount of the container also being porous inside the glaze. Fragile (brittle)
	(b) Porous (unglazed) Biscuit porcelain ..	do.	do.	do.

S. No.	Types of Filters	Special Properties	Common Uses	Remarks.
5.	*Glass filters.* (a) Sintered glass	Capable of being fitted in transparent glass containers allowing easy observation, resistant to acids chemicals, alkalies and heat, neutral, greater ease of manufacture in any shape and colour, advantage of sealing porous discs to glass apparatus and containers, rigid, wide application from 1000μ pore-dia to $0{\cdot}5\mu$ pore-dia, ease of controlling pore size, suitable for mass production.	(a) Laboratory filtering apparatus: Hospital - sterilization filters, bacteriological filters and blood filters. Mercury filters, vacuum filters, pressure filters, Soxhlet extraction filters, chemical filters, quantitative filters, micro-filters, etc., etc. (b) Industrial filters. Suction filters for acid tanks, corrosive and hot industrial gas filters, gas distributors.	Fragile, size restricted by manufacturing conditions.
	(b) Fibre glass ..	Permits free flow, not affected by heat or chemicals.	Filtration of industrial gases, Air-conditioning, freeing factory atmosphere of dust.	Needs special appliances to handle.

moulding the said paste into desired shapes, drying up to form caked forms and firing the said cakes in an electrically controlled furnace in an atmosphere of oxygen or air. The result is that the binder which serves to retain the shape of the filter up to the time of sintering completely burns away, allowing adhesion or sintering between the softened particles of glass to take place. After sintering, the filters are cooled slowly

Type of glass filter	*Field of Application*
1. Micro filters	Microchemistry.
2. Bacterial filters ...	Bacteriology, preparation of Blood sera, etc.
3. Laboratory filters— (i) Filter for qualitative analysis. (ii) Filter for quantitative analysis. (iii) Mercury filters. (iv) Vacuum filters. (v) Gas distributors (vi) Filter crucibles. (vii) Extraction thimbles, etc.	Chemical analysis in laboratories.
4. Industrial filters— (i) Fibre glass filters ...	Large scale dust filtration, purification of gases, etc.
(ii) Suction filters ...	Acid storage tanks, settling tanks, etc.
(iii) Gas distributors ...	Chlorination of rubber, chlorination of water, oxidation of oils, etc., where gases and liquids have to be uniformly distributed into another fluid medium.
(iv) Porous glass filter blocks.	Filtration of alkali lyes, commercial acids, etc.

and taken out. The porous glass bodies thus obtained are fused into shaped glass containers according to the purpose for which they are needed. A detailed description of a wide variety of porous glass filters made specially for scientific use as also some of the important applications of the glass filters already in vogue were given in the article referred to above. But a summary of the fields of application of the glass filter, both scientific and otherwise, given here will help to illustrate the ever widening field in which such filters may be employed.

Uses of Glass Filter

Investigators are finding yet newer fields of application for such filters and there are great possibilities of wider use. The application of porous glass filters in the field of electrolysis has recently opened yet another important field, as was envisaged by Paul H. Prausnitz, the pioneer worker in this field, as long ago as 1925.

Apart from all modern scientific and industrial uses, the sintered or porous filter can find a very useful place in our day to day life. This may appear novel for the present but if attention is given to suitable designs of some of the articles of domestic use and if filters of the requisite porosity and shape are selected there is considerable scope for employing sintered glass filters for meeting many of the everyday requirements of life where filtration is needed.

It may be that from the point of view of initial cost such filters may suffer from a slight disadvantage, but from the point of view of health and hygiene, and aesthetic appeal articles made with such filters will undoubtedly attract the attention of discriminating purchasers and find increasing use with the better classes of people. Unlike metal filters, glass filters will be easier to clean, and will not affect injuriously any of the edible articles with which they come in contact. They may be coloured to appear more attractive and neat and it will be no wonder if in homes of the future the familiar wire gauze and other filters are discarded in favour of the glass filter.

A few illustrations of articles of common use in which glass filters can be employed are given.

Fig. 1 represents the household coffee-extractor with a replaceable porous-glass disc. P. G. resting at the neck of the funnel F. To make coffee, some water W in the vessel V is first heated to boiling and then the funnel with the coffee powder on the disc. P. G. is placed in position as shown. A gentle heat under the vessel V causes the boiling hot water to rise in the funnel up to the coffee powder level due to slight pressure created inside V by heating. It soaks the coffee and on removing the flame the decoction is drawn back into the vessel V. By repeating the operation a decoction of the desired strength is obtained for use without any need for further filtration.

Fig. 2 is that of the familiar sanitary drinking-water-filter with the filtration thimbles a, a made of porous glass (with 25 to 50 μ pore diameter). The body of the container B and the lid C are made of coloured glass. Well water or tap water is poured in the upper compartment and filtered water withdrawn

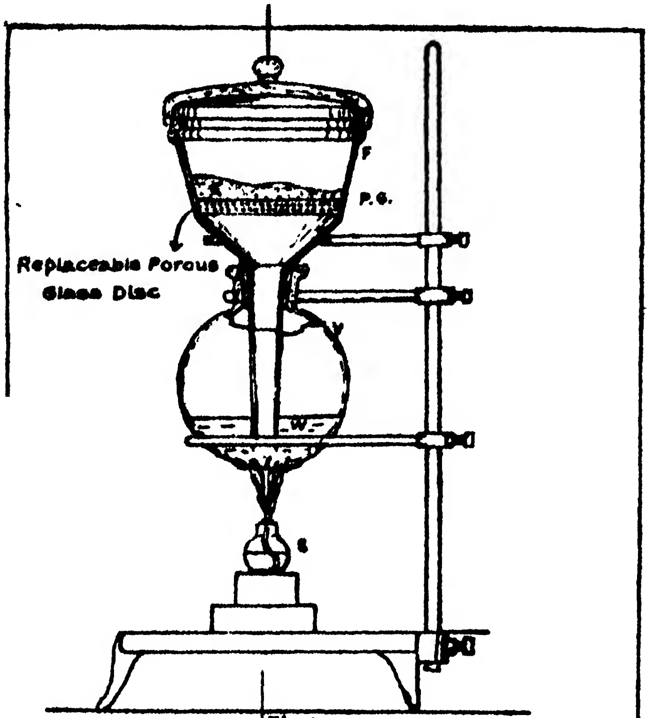
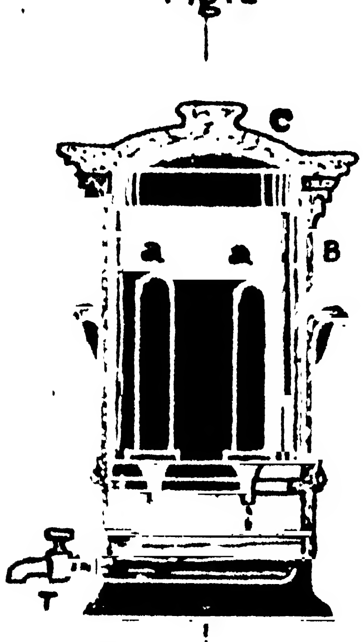
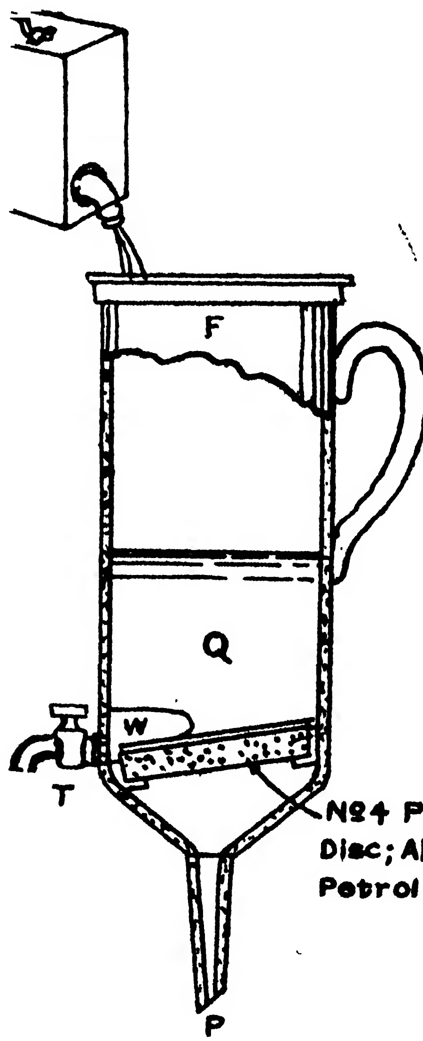


Fig. 1
Household Coffee Extractor

Fig. 2



Household Drinking Water-FILTER



Petrol Filter Funnel

FIG. 3

from the lower compartment through the tap T. The porous glass thimbles are capable of arresting dirt, germs and most of the harmful bacteria. Another advantage of the porous glass thimbles is that they can be obtained in any desired pore size to suit the requirements, depending on the nature of the water used.

Fig. 3 represents a petrol filtering funnel. A common trouble with petrol is that it occasionally gets contaminated with water during storage and this offers difficulty in separation. A porous glass filter of 25 μ pore diameter solves the difficulty admirably. Its

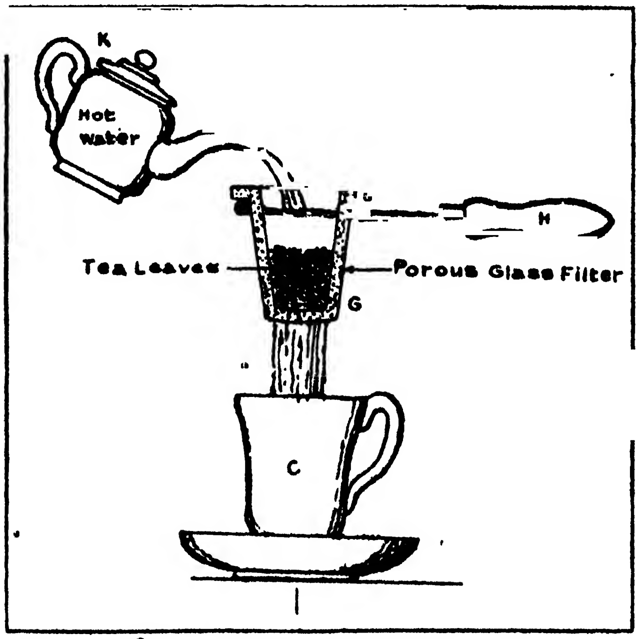


Fig. 4.

pore diameter is so adjusted that while it allows petrol to pass through freely, water is arrested. If a mixture of petrol and water is poured in the funnel F, the petrol filters down freely through the porous glass disc and water W collects towards the tap T on account of the inclined position of the porous glass disc. This water can be withdrawn through T even while filtration is going on.

Fig. 4 is that of a porous glass tea filter. Tea leaves are put in the porous glass filter G which is held by the handle H, and hot water from the kettle K poured over the tea leaves. The decoction of tea collects in the cup C. G can be lowered for a while into the contents of C in order to obtain a stronger decoction if needed and then taken out.

Fig. 5 is a smelling salt container with porous glass diaphragms a, a at either end enclosing the salt

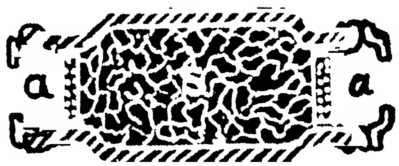


Fig. 5.

s-Smelling Salt
a-Porous Glass Diaphragm
c-Container

S in the container C. The pores of the glass discs a, permit only the gaseous vapours to be drawn through.

Such uses of porous glass filters in articles of everyday utility can be greatly multiplied when once the vogue has been started. In many cases the design or shape of the article may have to be modified to suit this change. This alteration coupled with an artistic application of colour effects may well lead to introducing a pleasing variety in a class of articles which through age old use have become more or less hackneyed and uninteresting. There is no doubt that the use of glass articles is rapidly increasing in all ranks of people and the employment of glass filters will be well in keeping with this progress.

RECENT ADVANCES IN THE CHEMISTRY OF SULPHANILAMIDES, 1940-1947

H. L. BAMI, B. H. IYER AND P. C. GUHA

INDIAN INSTITUTE OF SCIENCE, BANGALORE

Introduction

TREATMENT of infectious diseases by specific chemical agents had its origin in 16th century when the beneficial effect of mercury compounds for syphilis was first discovered. The next milestone in chemotherapy was the discovery of quinine in the 17th century for the treatment of malaria. No important advances was made until Ehrlich in 1910 discovered the effectiveness of arsphenamine in the treatment of syphilis. This period marks the beginning of a new era in the history of chemotherapy.

As early as 1909, Horlein(1) prepared an azo-dye of sulphonamide group which showed some protective action against β-haemolytic streptococcii. Although Eisinberg(2) in 1913 discovered the azo-dye "Chryosidin" (2′:4′ diamino-azobenzene) and introduced it as a chemotherapeutic agent, the results of its clinical application were not very satisfactory. In 1932, Meitsch and Klarer(3) prepared sulphonamido-chryosidin later known as Prontosil. The first clinical report on the usefulness of these azo-dyes as antibacterial agents was published by Foerster(4). However Domagk(5) aroused a wide spread interest amongst scientific and medical workers by publishing that prontosil had curative effect on coccal infection in mice. While confirming Domagk's work, Trefouel, Nitti and Bovet(6) showed that prontosil is broken down in the body and the activity of the drug is due to the sulphanilamide thus formed. This fact was soon confirmed by various other workers(7-9). Although Gelmo(10) prepared sulphanilamide as early as 1908, it was only after the discovery of its chemotherapeutic value that systematic work was started on the study of chemical and pharmacological properties of this and allied compounds, and a rapid progress followed. Ewins and Phillips(11) and Goldirev and Postorski(11A) synthesised sulphapyridine which was shown by Whitby(12) to possess marked antipneumococcal property. Sulphathiazole(13) and sulphamethylthiazole(14) were synthesised in 1939 and found to possess marked activity against all coccal infections and were less toxic than sulpha-pyridine. In the quest for new and more effective drugs, sulphadiazine was discovered by Roblin and co-workers(15) which proved still better than the previous drugs in many respects. Meanwhile Marshall(16) discovered sulphaguanidine which proved to be a useful remedy for intestinal infections while in 1939 Jensen *et al*(17) introduced the use of sulphanilamide for local application.

From 1940 and onwards the search for new drugs continued with equal vigour and their exhaustive pharmacological and clinical trials followed. It is not in the scope of the present review to include all the work done in this field but important results which have followed such painstaking investigations will be mentioned.

Sulphamethazine and sulphamerazine(15), two important analogues of sulphadiazine, are showing very encouraging results and certain added advantages over previous drugs and are coming in wider use gradually. Sulphapyrazine(18) is another active isomer of sulphadiazine discovered in 1941 which is very active, but lack of solubility and high cost of production are its two handicaps. The choice of a suitable drug to-day largely depends upon many factors like solubility, absorption, exeretion, toxicity, nature of disease and cost. These aspects have been dealt with in various books(19-21) and scientific articles(22).

Although lately overshadowed by antibiotics like penicillin and streptomycin, sulpha-drugs still hold their own and are useful for the following infections: haemolytic streptococcal, staphylococcal, meningococcal, pneumococcal and gonococcal, urinary tract infections, infections of the eye, plague, undulant fever and anthrax. Sulphaguanidine is very suitable for cholera, bacillary dysentery and ulcerative colitis because unlike the rest of the sulphas mentioned above, it is not absorbed and excreted rapidly. For the later types of infection, two recent sulpha derivatives, *viz.*, sulphasuxidine and sulphaphthalidine are receiving very favourable reports and have been put in the market. N^1-Benzoyl-sulphanilamide is also a possible future rival of sulphaguanidine(23). N^1-Acetylsulphanilamide (albucid-sulphacet-sulphamyd) is another useful drug for urinary infections. Sulpha-drugs are also being widely used for local application and for prophylactic purposes. Metachloridine(24), a metanilamide derivative, has been found to be a very potent suppressive antimalarial and is undergoing field trials. There are many other compounds of this family which though active are not in general use due to high cost and production difficulties. To overcome the solubility handicaps and reduce the toxicity, various water soluble derivatives and salts of these drugs have been prepared and are in clinical use. Sulphadiazine has also proved to be an effective antimalarial although its activity is of a lower order

than that of other antimalarials. The field of activity of sulpha drugs is being extended to other diseases and uptil now over 5000 compounds have been synthesised and many of them tested.

The mode of action of sulphanilamides has received considerable attention at the hands of various workers during the last 8 years, considerable advance has been made in this direction and the following hypotheses have been put forward:

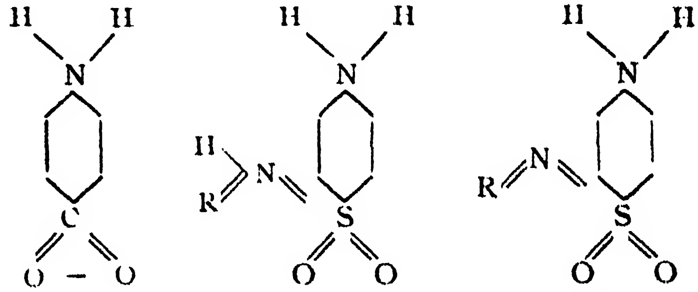
(1) Peptone Theory of sulphanilamide action by Lockwood(25).
(2) Peroxide-Catalase theory by Mellon *et al*(26).
(3) p-Aminobenzoic acid theory by Woods(27), Fildes(28) and Green(29).
(4) Carbonic anhydrase antienzyme theory by Mann and Keilin(30).
(5) Oxidation theory by Mayer(31), Shaffer(32) and Locke *et al*(32A).
(6) Acid dissociation theory by Schelkes(33, 34) and Fox and Rose(35).

All these theories are supported by sound reasoning and some of them are interrelated, but none of them individually can explain all the known facts. However, it will be fair to mention that *p*-aminobenzoic acid theory for the mode of action of sulphanilamides is receiving great attention and support and affords quite a rational explanation of a complicated phenomenon. According to this theory utilisation of *p*-aminobenzoic acid, an essential metabilite for organisms, is stopped by interference by sulphas and this is of the nature of a competitive inhibition due to structural relationship existing between *p*-aminobenzoic acid and sulphanilamide. In fact metachloridine and marfanil whose action is not antagonised by *p*-aminobenzoic acid are not true sulphas. Recently William(35A) has isolated 3-hydroxysulphanilamide as a new *in vivo* oxidation product of sulphanilamide and has discussed its bearing to the previous oxidation theory about the mode of action of sulphanilamides.

Sulpha-drugs have many limitations. Organisms not susceptible to these drugs cannot be treated by them and even in the same species of organisms, certain varieties do not respond to this treatment.

Continuous use of these drugs develops ***sulphonamide fast organisms*** which make the host a carrier of the disease. The toxic manifestations of sulpha-drugs are serious problems which have not yet been adequately solved. The nature of toxic reactions may be like headache, nausea, vomiting, cyanosis, hypersensitivity and drug fever. Anti-vitamin effect of these sulphas is another problem connected with toxicity.

As regards relation of chemical structure to activity of these drugs, various generalisations have been put forward by Crossley *et al*(36) and Trefouel *et al*(37) but they do not offer a satisfactory explanation for all the existing facts. Bell and Roblin(38) have tried to co-relate chemical structure with activity in the light of aminobenzoic acid theory of sulphonamide action. According to their theory, activity is co-related with the dissociation constant of the compound and if the electro-negativity of the substituent at N^1-position is known, activity (*in vitro* only) can be forecast. In accordance with this theory sulphadiazine manifests the maximum activity. The more a compound resembles *p*-aminobenzoic acid in its molecular structure and state of distribution of electric charge, the more it will be active *in vitro*, or in other words the more negative the "SO_2" group of a sulpha is, the greater the activity as thus it reaches near to the ionic state of *p*-aminobenzoic acid, (I, II, III).



(I) *p*-aminobenzoate ion (II) Un-ionised form of sulphas (III) Ionised form of sulphas

According to Kumler and associates(39, 39A) and Pushkareva and Kokoshko(40) a fundamental and essential requisite for activity seems to be the presence of the resonating form with coplanar amino-group and the negative character of "SO_2" group is a concommitant factor associated with resonating form. This theory adequately explains some of the exceptions of Bell and Roblin's(38) acid dissociation theory but has been criticised by Bordwell and Klotz(41) and Bordwell(42). Robin *et al*(38, 43) insist that the drug should be present in the body both in ionised as well as molecular form (II) for activity althuogh according to others (33, 35) only the ionised form (III) of drug is active. It is also observed that a drug should not be considered inactive unless it has been present in the blood in sufficient concentration, when considering the above theories. Antimalarial action of meta-chloridine and antibacterial action of marfanil cannot, however, be explained by the above theories. Although no definite conclusion has been arrived at regarding these aspects of sulpha-drugs, the results of investigation so far achieved have thrown considerable light on various aspects of chemotherapy and pharmacology.

Work on chemical, pharmacological and clinical aspects still continues and it is hoped that gaps left so far shall be filled. Sulphas have brought quick

relief at a low cost to millions of patients all over the world and this has got a great significance for poor countries like India.

For the present review for the period from 1940 to 1947 has been selected for the reason that an exhaustive review upto 1940 on this subject has been made by Northey(44). During this period a large volume of work has appeared on chemical, pharmacological and clinical aspects. The chemistry of sulphanilamides will be discussed in the present review under the following headings:

(1) N^1-substituted derivatives:
(2) N^4-substituted derivatives:
(3) N^1N^4-substituted derivatives:
(4) Miscellaneous.

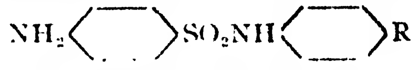
Sections 1, 2 and 3 have further been classified according to the nature of substituents under the following sub-headings: (*a*) Acyclic. (*b*) Isocyclic. (*c*) Heterocyclic. (*d*) Acyls. (*e*) Sulphonyl derivatives. (*f*) Anils. (*g*) Azo derivatives.

From the present survey of the important papers and patents dealing with sulphanilamides, it is interesting to observe that about 70 per cent of the work done during the period under review has been on N^1-substituted sulphanilamides of which N^1-heterocyclic derivatives cover about 52 per cent of the total. On the other hand the amount of work done on N^4-substituted sulphanilamides is only 8 per cent of the total.

1. N^1-Substituted Sulphanilamide

(a) *Acyclic substituents.*—Among N^1-alkyl substituted sulphanilamides(45, 46, 47, 55) and their nuclear substituted analogues(48), N^1-methyl and N^1-ethyl derivatives have proved to be as active as sulphanilamide, but long chain alkyl substituents destroy the activity probably due to lack of absorption.(58) Mono- and diethanolamine-derivatives are less active than sulphanilamide. Dialkylamino-alkyl (49, 50) and amino-alkyl(50, 52) derivatives have been synthesised but no pharmacological tests have been reported. N^1-sulphanilamido tritane and 4-sulphanilamido tetraphenyl methane and allied compounds have been claimed as lipophilic sulphas for combating T.B. infection (51, 53, 57). Various poly-sulphanilamides where two or more sulphanilamide groups are attached to alkyl or substituted alkyl chain have been reported(52, 54-56, 58, 59).

(*b*) *Isocyclic substituents.*—Recently large number of sulphanilamides derived from anilines substituted with two or more of nitro, amino, alkyl, halogen, alkoxy and cyano groups at different positions have been prepared to test their antimalarial and antibacterial properties(60-68, 70, 70A). Out of the isomeric sulphanilamidobenzoic acids(67, 68, 69) and its esters(69, 70) and its amides(69), the last mentioned are of interest because they resemble sulphaguanidine in being poorly absorbed in the system. While 2 or 4 sulphanilamido- 2 or 4 methoxy-phenyl-cyanides(71), 4-sulphanilamido-phenols(72) or resorcinols(73) and disulphanilyl-*p*-phenylenediamine and its benzidine and tolylenediamine isomers(70) have been prepared but no data on pharmacological examination is available. Sulphanilanilide (IV) substituted at 4′-position by arsonic acid(77-79), amino(75), fluoro(80, 81), phenyl(74) and substituted β-phenylethyl(76) radicals have been prepared out of which arsenic acid derivatives have been found to be less active than novarsenol while fluoro derivative was slightly active. Other similar compounds of that type were inactive.

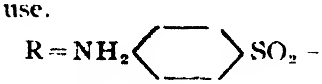


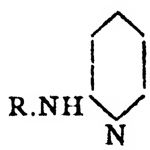
R = F, NH_2, AsO_3H_2 etc.

(IV)

Out of the various isomeric amino-sulphanilanisides reported by Bergeim *et al*(81A), 3-amino-4-sulphanilamido-anisole has shown definite antimalarial activity. Various N^1-(1, 2 or 4)-naphthyl sulphanilamides(57, 83, 90) N^1-sulphanilamido-naphthols(82, 87) and their naphthalene sulphonic acid(84, 85, 86) derivatives having substitutions in the naphthalene ring have been prepared for combating T.B. infections because such compounds are supposed to be more lipophilic in character. Polysulphanilamido-benzene, disulphanilamido-toluenedisulphonate and its benzidine and stilbene disulphonate analogues(59) as also 4 or 5 amino-2-hydroxy-benzenesulphonanilides and its other nuclear substituted derivatives(89) have been synthesised. Various 4-sulphanilamidobenzamides substituted at amide nitrogen by alkyl have been patented(89A).

(*c*) *Heterocyclic substituents.*—Stimulated by the discovery of sulpha-pyridine (V), sulphathiazole (VI), and sulphadiazine (VII) in 1939-40, by far the largest amount of work done during the period under review has been on N^1-heterocyclic sulphanilamides leading to the synthesis and evolution of sulphamethylthiazole (VIII), sulphamerazine (IV), sulphamethazine (X) and sulphapyrazine (XI). Many heterocyclic rings have been tried with fairly good results(91) but only these few compounds have established themselves for clinical use.





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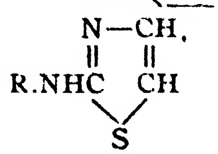

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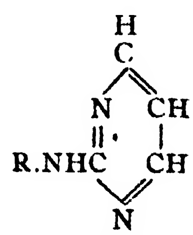

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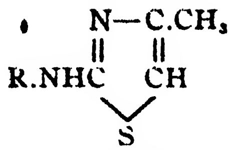
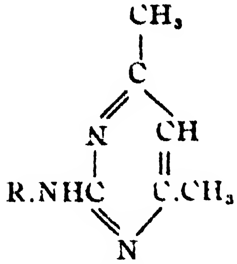


(VIII)



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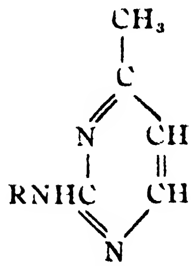

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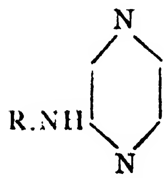


(XI)

In clinical practice sulphapyridine is being discouraged due to its toxicity. Sulphathiazole and sulphadiazine are usually the drugs of choice to-day while sulphamerazine and sulphamethazine are also gradually coming up due to their certain advantages over the drugs previously mentioned(23).

2-Sulphanilamido-pyridine (V),(92, 93, 95-99) its 5-halogen, alkyl or alkoxy(94, 99, 99A), 6-piperidino, halogen or alkyl(103, 99A) and 1,2-dihydro-analogues(100, 283) have been reported to be therapeutically active. Sulphidine (2-sulphanilamido-6-methylpyridine) closely resembles sulphapyridine in its activity(101, 102). 3,4 and 5-sulphanilamidopyridines(98, 99, 103 and α-2,3 and 5-sulphanilamidopyridines have been reported out of which the latter group showed activity *in vitro*. N[1]-(1-(3-pyridyl)-ethyl) sulphanilamide and N[1]-(2-(2-pyridyl)-ethyl)-sulphanilamide where sulphanilamide is attached to a N-hetero-cyclic ring through an ethylenic linkage(96, 105 and neuclear substituted derivatives like N-2-(3-bromo - 4-amino-phenylsulphonamido) - pyridine(106) and 2-(2 :4-dimethyl-5 - amino-benzenesulphonamido)-pyridine have been described but no pharmacological data has been reported.

Among, 2-sulphanilamidothiazole (VI)(15, 93, 109, 113, 117, 118) and its 4-(alkyl, dialkyl, aminoalkyl, alkoxy, aryl and mercapto) substituted analogues, compounds with a long alkyl chain at 4-position of the thiazole ring are supposed to give derivatives possessing lipophilic properties for combating T.B. and leprosy(112). 2-Sulphanilamido-5-(halogen, alkyl or carbethoxyalkyl)-thiazoles(94, 110, 111, 116, 121, 123) and its 4 :5-disubstituted analogues(110, 115, 116, 121-123, 123A), have also been reported but with activities slightly less than that of sulphathiazole. Sulphanilamide attached to thiazole ring at 5 position and its 3-alkyl and 2 :4-dimethyl-analogues have been studied and although 5-sulphanilamidothiazole is active, it has no advantage over other drugs(127). N[1]-Desoxy-ephedronium sulphathiazole and N[1]-ephedronium sulphathiazole have been prepared for vasoconstrictive use and opthalmic purposes by Hamilton *et al*(128), 3-Methyl-2-sulphanilamido 2 :3-dihydrothiazole is also reported to be active(100). Wojahn(106) has reported some neuclear substituted sulphamethylthiazoles without pharmacological data. Jensen(167), Guha and Roy(129) and Backer and Jonge(114) have reported various 2-sulphanilamido-4-alkyl or aryl selenazoles having selenium in place of sulphur of the thiazole ring. Raiziss and Cleurence(131) have prepared 2-sulphanilamidothiazoline which is as good as sulphathiazole with the added advantage of low toxicity. Other 2-sulphanilamido 3, 4 or 5 alkyl or aryl substituted thiazolines have also been reported to be active,(111, 116). 2-Sulphanilamido-benzothiazole(15, 115, 119), its 4 :5-dihydro(109) and 4 :5 :6 :7-tetrahydro(113) analogues, and similar other derivatives of alkyl or aryl substituted benzothiazole(117, 132) possessing low activity, have been prepared.

2-Sulphanilamido pyrimidine (VII)(15, 135, 136, 139, 141, 143-146), 2-sulphanilamido-4-methylpyrimidine (IX) (15, 133, 135-137, 139-142, 144, 145) and 2-sulphanilamido-4 :6-dimethylpyrimidine (X) (133-136, 138, 139, 142, 144-146) have been reported by a number of authors and are the most potent of all the drugs of this group. Various other derivatives of the type 2-sulphanilamido-4 :6-dialkyl or dialkoxy pyrimidine(133-138, 147, 150, 152), 5-sulphanilamido-2-alkyl or alkoxy pyrimidine(138, 140, 144), 4-sulphanilamido 5 or 2 :6 (halogen, alkyl or alkoxy) pyrimidines(134, 144, 147), 6-sulphanilamido-2 :4 or 4-alkyl pyrimidines(133, 137, 140, 148, 149, 151), 2-sulphanilamido 5 and/or 4-(alkyl or halogen) pyrimidines(62, 94, 133-137, 139-144, 146, 152), and 2-sulphanilamido 4 or 6 alkoxy-pyrimidines(147A) have been synthesised and these types of compounds have shown considerable activity against coccal infections. However, 2-sulphanilamido-5-chloropyrimidine has shown activity higher than that of sulphadiazine against avian malaria(94). 2-Sulphanilamido-pyrimidone and its substituted derivatives, and 2-sulphanilamido-1 :3 :6-trimethyl-5 :6-dihydropyrimidine have been reported by Ganapathi(141) without pharmacological data. 2 :6-Disulphanilamido-pyrimidine, sulphanilamido uracil(144) and N[1]-ephedronium sulphadiazine(128) type of compounds have also been reported.

2-Sulphanilamidopyrazine (XI) (154, 103) and its 4- and/or 6-alkyl-substituted analogues(153) have been reported to be active but the ortho-isomer of sulphadiazine is completely inactive *in vivo*(153A).

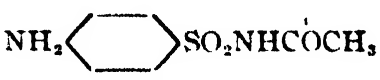
Sulphanilamido radical has been introduced to quinoline molecule (substituted with nitro, amino, alkyl, halogen, or alkoxy radicals) at all positions from 2 to 8, but these compounds have not shown very encouraging activity(68, 84, 95, 98, 155-159).

Various other compounds derived from this group are N^1-lepidylsulphanilamides(161), N^1-(2 - (2 - quinolyl) ethyl)-sulphanilamide(105) and *p*-aminophenyl-(1 : 2 : 3 : 4-tetrahydro (1) isoquinoline) sulphonamide(160). All of them are inactive.

N^1-Sulphanilamido heterocyclics derived from the following heterocyclic rings substituted or otherwise have been reported: piperazine(97); 1 : 3 : 4-thiadiazole(15, 166, 167, 176, 179, 185, 193, 197, 198, 204); pyrazolone(15, 113, 170, 196); quinicine(162); hydroethyl-apocupreicine(162); 1 : 4-napthaquinones(82, 83, 90, 207); benzotriazole(163, 190); indazole(163, 168, 190); indotriazine(163, 190); thiazolidine(164); benzimidazole(103, 187, 206, 206A); phenothiazine(103, 167); pyrrole(173); triazole(103, 165, 169); quinoxaline(142, 194, 195, 200, 202); oxazoles(122, 172, 176 177, 192); pyrazole(184, 165); alkylfurazan(166, 203); oxadiazoles(166, 176, 185); tetrazoles(166, 184, 185; antipyrine(171, 182); thiazoline(174) and its 5 or 4-alkyl or aryl substituted analogues; phenanthrene(175); chrysene(175); benzofuran(175, 188); carbazole(175, 189); coumarin(175); acridine(175); pyridazine(176, 176A); triazine(176); histidine(178); thiophene(180, 183, 186); thiazolone(181); anthine(187); pyran and thiopyran(191); thiotriazole(193); indole(201, 204). According to Sjogren and Berlin(90) 2-sulphanilamido-1 : 4-naphthaquinone is as active as sulphapyridine. It has been found that 3, 5, 6 or 7-sulphanilamido indazoles(168), 1-sulphanilamido-1 : 3 : 4-triazole(165), 3-sulphanilamido indole(201) and 2-sulphanilamido-phenyloxazole(172) are very active in experimental trials. Naphthaquinone derivatives of the type N^1 or N^1-(2-methyl-1 : 4-napthaquinone-3-yl)-sulphanilamides and their N^1-heterocyclic substituted analogues have been prepared in order to test their antitubercular property. 2-Sulphanilamido quinoxaline has been found to be four times as effective as sulphanilamide and remains in the blood for a long time. It has also been proved to be as good as sulphadiazine in avian malaria by Seeler *et al*(208). Guha and Dogras(209) have reported some sulphanilamides of thiobiazolephenyl sulphides.

(*d*) *Acyl substituents.*—The important drugs of this group are sulphaguanidine (XII), sulpha-acetamide (XIII), and N^1-benzoylsulphanilamide (XIV) whose activities and uses have already been discussed.

(XII)



(XIII)

(XIV)

Sulphanilylguanidine(15, 212, 214, 177) and its alkyl substituted(210, 210A, 213, 213A, 211) aryl subsubstituted(227) and acyl substituted(211A) derivatives have been reported. While Price(215) has synthesised disulphanilylguanidine, Dewing *et al*(233) have prepared disulphanilylethyleneguanidine. Although sulphanilyl biguanides(210, 216, 217, 218) and their alkyl and/or aryl substituted analogues(210, 216-218) have been prepared, no pharmacological data are, however, available. Other derivatives of this type which have been reported are sulphanilylcyanamide(210), sulphanilyl cyanoguanidine(219) and sulphanilyl guanylurea(210, 219).

Sulphanilyl alkyl or aryl isothiourea(228, 210, 220, 224), sulphanilylurea(222, 210, 220, 221, 224, 226, 225, 227) sulphanilyl-thioureas(221, 222, 223), sulphanilyl-urethane(222), and 3-sulphanilyl-2-benzyl-2-thiopseudourea(227) have been reported. Guha and Handa(229), and Guha and Mahadevan(230) prepared some sulphanilyl semicarbazides and thiosemicarbazides as also sulphanilamides containing alkylthiol-1-substituted thiosemicarbazides. Jensen(231) and others(245, 246) have reported 1,3-disulphanilylurea to be good for dysentery and gonorrhea, though slightly toxic.

Crossley *et al*(232) prepared a series of N^1-alkylsulphanilamides derived from long chain aliphatic acids and further work in the same series has been done by Dewing *et al*(232), Arnold *et al*(234) and English *et al*(235). The antibacterial property of these compounds is rather poor excepting N^1-acetylsulphanilamide (XIII), but long chain aliphatic acyls of sulphanilamide *viz.* N^1-chaulmoogry-sulphanilamide has shown encouraging activity against T.B. and leprosy.

N^1-Acyl derivatives of sulphanilamide obtained from alkyl, alkoxy or mercapto substituted benzoic acid have been reported(232, 236-238, 306). Other isocyclic-acyl radicals used are 3-hydroxy-2-naphthoyl(232, 239), cinnamoyl(232, 237), hydrocinnamoyl(232), acrylyl(238), 9-phenanthrylcarbonyl(239) and anthranylcarbonyl(239).

Jain *et al*(240) have prepared N^1-heterocyclic acylsulphanilamides derived from various heterocyclic acids while N^1-picolinyl sulphanilamide(237, 238), N^1-pyrazinolylsulphanilamide(241), N^1-(cyclopentane carbonyl)-sulphanilamide(242), N^1-(2 : 2 : 6-trimethylcyclohexane-carbonyl)-sulphanilamide(242) and N^1-campholylsulphanilamides(242) have also been reported. The last three compounds are active against staphylo and pneumococcal infections although they show poor response against streptococci.

(*e*) *Sulphonyl derivatives.*—Although N^1-alkyl or aryl sulphonylsulphanilamides have been prepared by Croseley *et al*(243) and others(288, 244), no tests have been reported.

N^4-Substituted Sulphanilamides

(*a*) *Acyclic substituents.*—As the therapeutic properties of this class of compounds are primarily the therapeutic properties of parent drug which is released *in vivo*, no noteworthy advance has been made during the last seven years. N^4-Triphenylmethyl sulphanilamide(51, 53) has been prepared as a possible antitubercular drug. Bami, Iyer and Guha(54) have synthesised N^4, $N^{4'}$ alkylene-bissulphanilamides, the length of the carbon chain varying from C_1 to $C_{..}$ N^4-Methylsulphanilamide(247) as well as N^1-sulphanilamido-α-aliphatic esters and acids(248) have been reported, out of which, drugs of the later group have shown considerable activity in *in vitro* tests.

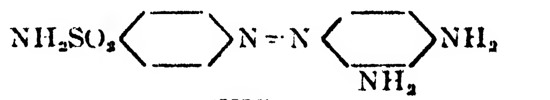
(*b*) *Heterocyclic substituents.*—N^4-(2-chloro-7-methoxy-5-acridyl) sulphanilamide(249), 1-(4-sulphamylphenyl) -3- (4-sulphamylphenylimino) - 5-aryl - 2-pyrrolidone(250), N^1-(9-acridyl)-sulphanilamide(251) and 2-*p*-sulphamylphenyl-aminothiazole and its thiazoline analogues(251) have been reported to possess poor activity. Various N^1-(2′-lepidyl)-sulphanilamide, N^1, $N^{4'}$-quinaldyl sulphanilamide and its 6′ or 8′ methoxy analogues have been described(252, 267).

(*c*) *Acyl substituents.*—*p*-Sulphamyl-phenylurea (223, 245, 253) and *p*-sulphamyl-phenylguanyl-substituted-phenylguanides(254) are classified as the N^1-acyl derivatives of carbonic acid. A number of N^1-acyl sulphanilamides from long chain aliphatic acids(234), 255, 257), halogen-substituted aliphatic acids(256) and aliphatic dicarboxylic acids(256, 258-261) have been reported. Morgan and Walls(262) have prepared N^1-hydroxyacylsulphanilamides which were very effective against experimental coccal infections. Gaind *et al*(263) have reported various *p*-(α-aryl-acetamido)-benzenesulphonamides. N^1-Alkylene-bis-($N^{1'}$-acyl-sulphanilamides) have been prepared by Bami, Iyer and Guha(264) where the acyl group is derived from monocarboxylic aliphatic acids containing 2 to 7 carbon atoms. Various other N^4-acylsulphanilamides derived from aryl acids have been prepared but no pharmacological data are available.(255, 256, 257) Mehltretter(257A) prepared some N^4-acylsulphanilamides derived from sugar acids but activity was low.

(*d*) *Sulphonyl derivatives.*—N^4-arya-sulphonyl-sul-phanilamides have been synthesised for testing their activity against rheumatism, lumbago and other urinary infections.)265) N^1-Sulphanilyl-sulphanilamide and its derivative have also been patented(266).

(*e*) *Anils.*—Aliphatic aldehydes having 3-18 carbon atoms in the alkyl radical have been condensed with sulphanilamide to give the anils for testing against bacterial infections.(268) Various naphthylidene sulphanilamides(269) and anils of sulphanilamides derived from substituted benzaldehydes(163, 270, 233) possessing low activity have been reported.

(*f*) *Azo-derivatives.*—Magidson and Rubstov(271) prepared 30 azo-derivatives of sulphanilamide of prontosil type (XV) and discovered that replacement of sulphamyl group in prontosil lowers the activtiy, while replacement of metaphenylene-diamine by 6-amino- or 8-hydroxy-quinilines give rise to drugs of higher activity

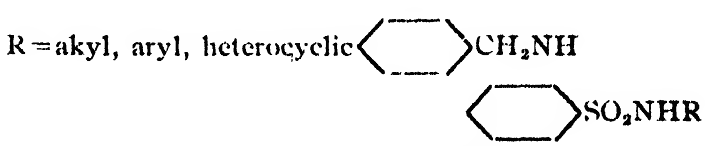


(XV)

Sulphanilamide has been diazotised and coupled with hydroxy-aromatic compounds,(272) barbituric acid,(273) aceto-acetic ester(273) and 6-aminoquinoline(162) to give the corresponding azo-dyes. Compounds of the type 3-(3′-methyl-4′-hydroxy or amino)-naphthyl-azobenzene sulphanilamide and its N^1-pyridyl, pyrimidyl and thiozylyl analogues have been found to possess good anti-haemorrage property.(274) Mazza and Migliardi(275) have prepared compounds of the type 1, 3-dimethyl-2 : 6-dioxo-8-(*p*-sulphamyl-phenylazo)-purine which were active against streptococci. Azo compounds obtained by coupling diazotised sulphanilamide with trivalent antimony compounds like hydroxides or acids have been prepared to combat protozoal infections.(276, 277)

N^1-N^4-Substituted Derivatives

(*a*) *Acyclic substituents.*—N^4-Triphenylmethyl derivatives of sulphathiazole, sulphapyridine and sulphadiazine have been prepared for obtaining lipophilic sulpha-derivatives.(51, 53) Various N^4-alkyl-N^1-pyridine, quinoline or isoquinoline sulphanilamides have also been patented.(278) Walker(279) has prepared N^1-β-diethylaminoethyl-N, N'-pentamethylene-sulphanilamides. N^4-Benzyl-N^1-alkyl, aryl and pyridyl-sulphanilamides (XVI) have been reported to be less active than sulphanilamide(280, 281, 283). 2-*p*-Hydroxylaminobenzene-sulphonanido-thiazoles have been described in a patent.(282)

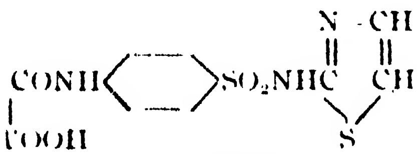


(XVI)

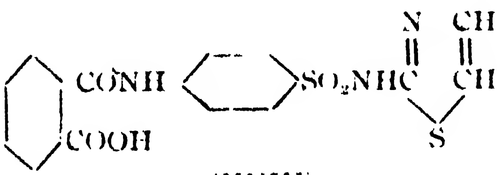
(*b*) *Isocyclic substituents.*—N^4-Aryl-N^1pyrimidyl, quinolyl, and isoquinolyl sulphanilamides have been reported.(278)

(*c*) *Heterocyclic substituents.*—N^4-Acridyl-N^1-alkyl-aryl or pyridyl sulphanilamides(249, 250), N^4-pryazalone-sulpha-pyridine(282) and N^4-(1 : 4-naphthaquinone-2-yl)-N^1-aryl-pyridyl or thiazoyl sulphanilamides(285) have been reported, the last being inactive against streptococcal, pneumococcal and tubercular infections.

(*d*) *Acyls substituents*.—The two important members of this group are sulpha-suxidine (N^4-succinyl-N^1-2-thiazolyl-sulphanilamide)(286-289, 260) (XVII) and sulphaphthalidene-(N^4-phthalyl-N^1-2-thiazolyl-sulphanilamide(289), (XVIII) which have given encouraging results against intestinal infections, the latter being two to four times as active as the former. Goldberg *et al*(290A) have claimed that chloride of 2-(N^4-α-pyridinium-propionyl-sulphanilamido) pyrimidine to be as effective as sulphasuxidine as an intestinal antiseptic.



(XVII)



(XVIII)

Poth and Ross(289) have reported various N^4-succinyl, quinolyl, phthalyl, malonyl, oxalyl and maleyl derivatives of various N^1-substituted sulphanilamides and has concluded that liberation of active drug *in vivo* is not solely responsible for their activity. Similar derivatives have also been reported by a number of other workers.(286, 260, 288, 290, 291, 291A, 292), N^4-Acyclic-acyl-sulphono-hydroximides, (293, 294), N^4-acyclic-acyl-sulphapyridines(295-300) and N^4-isocyclic acyl-sulphathiazole(297-299) have been reported, but the last two type of compounds were inactive against tubercular bacili. N^4-Chloro or amino acetyl-derivatives of N^1-pyridyl, 4-methyl-thiazolyl, and 4-methyl-pyrimidyl sulphanilamides, though less toxic, were found to be less active(301). Various N^1, N^4-di-acyclic and di-isocyclic acyl sulphanilamides(302, 303), para alkyl or aryl sulphamyl-phenyl ureas,(245, 253) *p*-2-thiazolyl or 2-pyrimidyl sulphamylphenylguanidine arylguanides,(254), ethylene-bis-N^1-(4^4-acyclic-acyl-sulphanilamides(248), N^4-heptoyl-N^1-aryl or heterocyclic substituted sulphanilamides(300), 2:6-bis-N^4acetyl-sulphanilamido)-thianthrene(304) and sulphanilamide derivatives of cholestrol ester of carbonic acid have also been reported.

(*e*) *Sulphonyl substituents*.—N^4-Sulphanilyl-N^1-dimethyl-sulphanilamide (uleron) has been reported by Sakai and Yamamoto(307) which has been used previously in Europe to combat gonococcal infections.

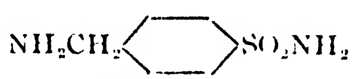
(*f*) *Anils*.—Anils of N^1-alkyl, aryl and heterocyclic sulphanilamides derived from substituted aromatic aldehydes have been described, but although having low toxicity, their activity was poor in general.(163, 248, 280, 308-310)

(*g*) *Azo-derivatives*.—Various N^1-alkyl sulphanilamide azo-dyes derived from aromatic(318) amino or hydroxy compounds, purines,(275) substituted quinolines(311) and substituted pyridines(312) have been reported. While various N^1-heterocyclic sulphanilamides have been diazotised and coupled with aromatic amino or hydroxy compounds,(313, 314, 272) amino or hydroxy quinolines,(274, 338) and substituted pyridine(316), N^1-Aryl-sulphanilamides have given corresponding azo-dyes with substituted quinolines(315, 317) and pyridines(316). Some azo-benzene-*p*:*p'*-disulphonamides(92, 329) and allied compounds(319) have been reported, but no pharmacological results are available.

Miscellaneous

Salts of sulphanilamides. Acid salts of sulphaguanidine derived from mineral and organic acids,(321) as well as quinic acid, glucuronic acid and galacturonic acid salts of sulphanilamide(320, 322) have been patented. Similarly quaternary ammonium salts,(323) silver salts(324, 326) of N^1-heterocyclic sulphanilamides have been reported apart from their alkali salts which are in general clinical use. Salts of sulphanilamide derived from sodium, potassium, aluminium, bismuth, copper, silver, magnesium manganese and zinc(327) have also been patented. These salts have better solubility and low toxicity.

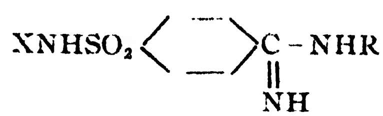
Homosulphanilamides. 4 - Homosulphanilamide (XIX) (Marfanil or Mesudin), its N^1-heterocyclic derivatives(331, 332) and N^4-acyl or aryl-N^1-heterocyclic analogues(332-334) have been prepared.



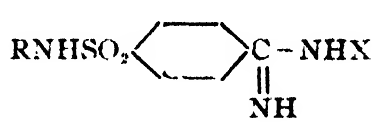
(XIX)

p - (β-Amino - ethyl) - phenylsulphonamide(335, 375) has been found to be as good as marfanil in activity. Marfanil itself is very suitable for local application and combating gas gangrene infection.

p-Sulphamyl-benzamidines.—Various substituted *p*-sulphamyl-benzamidines of the type (XX) and (XXI)(335-337, 339-342, 341A, 342A, 338) and the meta-isomers have been reported by various authors.



(XX)



(XXI)

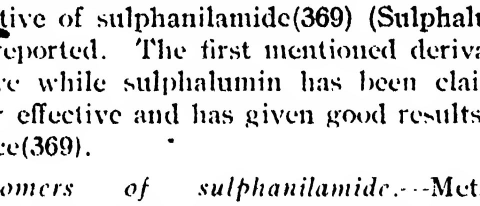
R=H, alkyl, aryl or heterocyclic
X=H, or alkyl

Sulphonamides of amino-heterocyclics.—Various 2-amino-7-(alkyl-aryl or heterocyclic) sulphamyl pyridines(344-346), their 5-sulphamyl isomers(347), 5-nitro - 8 - quinolyl - sulphonamides(348), 2-amino - 5-methyl-5-thiazolyl sulphonamide(350), N-acetyl-4-methyl-2-thiazole-sulphonamide(349) and 2-amino-6-benzothiazole-sulphonamides(351-353) and their 4 or 6 iodo-analogues have been reported, but no data regarding the activity of these compounds are available.

Soluble derivatives of sulphanilamides.—Drugs of low toxicity with high solubility and activity have been obtained by reacting sodium formaldehyde-sulphoxylate with sulphanilamide or sulpha-pyridine(354, 355). Glucosides of various substituted sulphanilamides derived from different sugars have been prepared to reduce the toxicity of these drugs and render them more soluble and effective.(356-362) Alkyl and aryl aldehyde-sodium bisulphite compounds of sulphanilamide have been prepared(363, 364, 365, 369).

Inorganic derivatives of sulphanilamides.—A few mercury derivatives of sulphanilamide,(365, 368, 368A) 4-pyridyl, thiazol, pyrimidyl, and guanyl sulphamyl-benzene-stibonic acids(367) and an aluminium derivative of sulphanilamide(369) (Sulphalumin) have been reported. The first mentioned derivatives were inactive while sulphalumin has been claimed to be widely effective and has given good results in clinical practice(369).

Isomers of sulphanilamide.—Metachloridine (XXII) (2-metanilamido-5-chloro-pyrimidine) and N^1-alkyl or heterocyclic derivatives of metanilamide and orthanilamide have been reported by English *et al*(24) and others,(369A) out of which metachloridine is the most potent antimalarial being 16 times as active as quinine and 6 times as active as sulphadiazine in experimental avian malaria. On the model of metachloridine Sheperd and English(378) have prepared N^1-methyl-2-metanilamido-4-methoxyl or alkyl pyrimidine but they were found inactive when tested against avian malaria. Some 2-(*o*- and *m*-sulphanilamidophenyl)-thiazole and their pyrimidine analogues,(104) *p*-(*p*- or *o*-aminophenyl)-benzene-aryl-sulphonamides(370, 371) have been reported.



(XXII)

N^4-Nitro-N^1-alkyl or aryl benzene-sulphonamides(372), diphenyl-amine-4 : 4′ - disulphonamides(373), *p*-alkoxybenzene-sulphonamide(374), 2-(2 or 4-amino or nitrophenyl)-ethane·sulphonamides(42, 375) and its methane analogues(375) have been reported but no pharmacological tests are detailed. Various *p*-sulphamylphenylhydrazones(376) and N^4-acetyl-sulphanilyldialkyl-sulfilimines(37--) possessing low activity have been prepared.

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TIRAK DISEASE OF AMERICAN COTTONS IN THE PUNJAB AND ITS REMEDY

R. D. ASANA

INDIAN AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI

THE Punjab-American cottons which have, according to Sir Herbert Stewart, conferred a boon on the Punjab cultivators to the tune of crores of rupees a year, received their first set back when they suffered from a disease called '*tirak*' (Fig. 1). The bolls

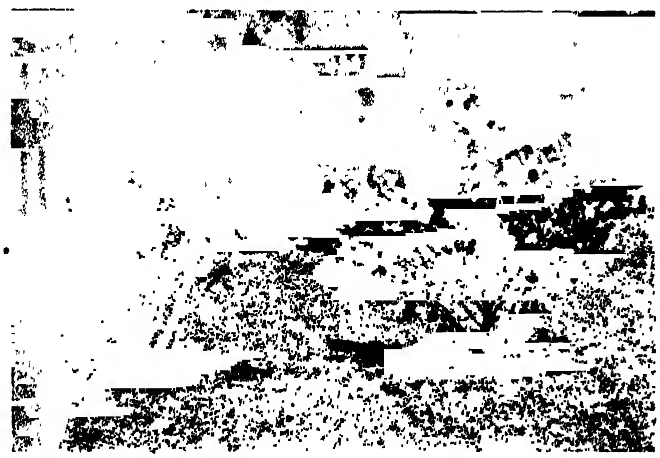

FIG. 1. *Left*—A normal crop of Punjab-American cotton showing well opened bolls. *Right*—A *tirak*-affected crop of Punjab-American cotton on soil with saline subsoil. The leaves have drooped. The lower leaves are shed. The bolls are small and have cracked prematurely.

opened prematurely, the seeds were not well filled and the fibre was trash. The yield was reduced by about 50 per cent. Crop failures occurred in 1919, 1920, 1921, 1926, 1927, 1928, 1931 and 1932. It was calculated that a general fall in yield by 2 maunds per acre involved a net loss of two crores of rupees in a season on the basis of one million acres under cotton and ten rupees as the price of one maund of seed cotton.

In 1935 the first scientific project to investigate the cause of this trouble was jointly undertaken by the Punjab Government and the Indian Central Cotton Committee, and Professor R. H. Dastur (then Professor of Botany, Royal Institute of Science, Bombay) was entrusted with the direction of the investigation. The investigation was completed in 1942 at a total cost of about 4 lacs of rupees. Prof. Dastur's approach to the problem was essentially physiological which was amply justified by the valuable results achieved. This work was perhaps the first of its kind in India illustrating in a very practical way the potentialities of study of crop physiology.

It was generally believed prior to 1935 that *tirak* appeared sporadically in certain years, thus laying much greater stress on the seasonal variations rather than on the soil factors. The observations during 1935 and 1936 showed, however, that the symptoms of *tirak* were present at several places in spite of the fact that these two seasons were normal so far as cotton production was concerned. It was this observation that suggested the first clue towards the solution of the problem. The symptoms shown by the cotton crop in the years of failure were reported to be premature yellowing and reddening and shedding of the leaves in the months of September and October (at the fruiting stage) followed by premature opening of bolls. Subsequent studies revealed, however, that such premature yellowing of leaves did not always precede premature cracking of bolls. In such cases the leaves in the month of September lost their shining appearance and assumed a drooping position a week after irrigation which was generally given at intervals of three weeks. The leaves were also prematurely shed. This difference in the symptoms, yellowing of leaves in one case and drooping in the other, pointed to two different soil conditions being responsible for *tirak*. The details of this intricate piece of investigation have been published in the form of a monograph by the Indian Central Cotton Committee, and only the main findings are described here.

CAUSES OF *Tirak*

That the two types of physiological disturbance occurred as a result of two different unfavourable soil conditions has already been mentioned. Yellowing

of leaves was generally observed in light sandy soils deficient in nitrogen. The crop made a vigorous growth at first but subsequently at the time of fruiting, it developed symptoms of nitrogen starvation, *viz.*, yellowing of leaves, which was followed by premature cracking of bolls. Considerable accumulation of starch was noticed in the mesophyll cells of the leaf, probably as a result of a drop in the rate of protein synthesis due to nitrogen being in short supply. Later a substance giving all the reactions of "tannin" appeared and accumulated in the leaf cells.

Drooping and premature shedding of leaves occurred, on the other hand, in sandy loams with abnormal concentration of soluble sodium salts in the subsoil at a depth of two to three feet (Fig. 2)

FIG. 2 A Punjab-American cotton crop on soil with saline subsoil showing the drooped leaves on account of unavailability of water.

The first two feet of soil profile being non-saline, the crop made a good growth during the first three months. Later, with further increase in foliage and consequent increase in demand for water, the crop showed signs of water deficit a few days after each irrigation. The maximum leaf area was attained generally in September and from this time onward the leaves drooped as soon as the upper soil depth dried up after each irrigation, moisture in the saline subsoil being not readily available. Subsequently the leaves shed and the bolls mostly situated towards the top of the fruiting branches remained small and cracked for want of moisture and nourishment. The crop showed signs of gradual desiccation in such soils.

CAUSES OF WIDESPREAD COTTON FAILURE

The two types of physiological disturbances produced *tirak* every year whenever there was either a very light sandy soil or a patch with a highly saline subsoil. How did then a widespread incidence of *tirak* occur periodically in the past? In the year 1939, a widespread failure of cotton occurred and the study of the weather conditions during that season provided an additional clue to the solution of the problem. It was observed that *tirak* appeared extensively in the fields where it occurred only in patches during the previous seasons. Chemical analysis of the subsoil beyond the limits of these patches (on which *tirak* was found in the previous years) revealed that there was medium or low salinity in such extended *tirak* patches. In September and October there occurred long spells, of ten to twenty days duration, of unusually high maximum temperature. The crop was thus subjected to an intense atmospheric drought at a critical stage when bolls were developing. In saline subsoils the crop was invariably subjected every season to a physiological (soil) drought but the onset of the atmospheric drought further accentuated the water strain. The atmospheric drought also imposed a considerable water strain in the crop situated on subsoils with medium or low salinity and thus brought about *tirak* which would not have appeared otherwise. On normal sandy loams the crop was able to cope with the water strain imposed by the atmospheric drought and thus remained free from *tirak*.

A study of the maximum temperatures in September and October in the previous years during which widespread failure occurred revealed the occurrence of similar spells of abnormal maximum temperatures. A statistical analysis of temperature and yield records for the period 1921 to 1935 revealed a significant negative correlation between the temperature above the mean maximum for a period of 8 days or more and the yield of cotton in different districts. When monthly means of maximum temperature were considered, no such correlation was found. Thus a hot spell of 10 to 15 days during this critical period was enough to upset the delicately adjusted water balance of the crop and cause a permanent damage.

REMEDIAL MEASURES FOR *tirak* ON THE TWO SOIL TYPES

Once the nature of the physiological disorders underlying the development of *tirak* was diagnosed, the way to find remedial means became fairly clear. With the application of sulphate of ammonia to the light sandy soils neither did the premature yellowing and reddening of leaves nor the cracking of bolls with the immature seeds occurred and the yield of seed cotton increased considerably.

Extra irrigation either in heavier doses or at more frequent intervals at the fruiting stage, was found to alleviate *tirak* caused by physiological drought in saline subsoils. Neither did the leaves droop nor did they shed prematurely and the bolls

opened well. The exceedingly heterogeneous nature of the Punjab soils, however, precluded the application of these simple remedy on an extensive field scale. Normal soil was found mixed up in small areas with light sandy and saline subsoil types. Application of sulphate of ammonia did not remedy *tirak* occurring in soils with light subsoil salinity. Similarly extra irrigation to a light sandy type at the fruiting stage, did not alleviate *tirak*. Thus paradoxically enough two different physiological conditions associated with *tirak* called for a common remedial measure on account of the extreme heterogeneity of the soil.

Common remedial measures for *tirak*

The most practical remedial measure that suggested itself was to so adjust the growth of the crop that the two deficiencies, *viz.*, nitrogen and water, from which it suffered under these soil types could be mitigated. Reduction of plant size by curtailing vegetative period through delayed sowing was the next step attempted.

Cotton was sown at that time in the Punjab during the month of May. The first experiment in 1938 with May and June sowings in both soil types showed the latter to be eminently effective in reducing *tirak* (Figs. 3 and 4); in the May-sowing *tirak*

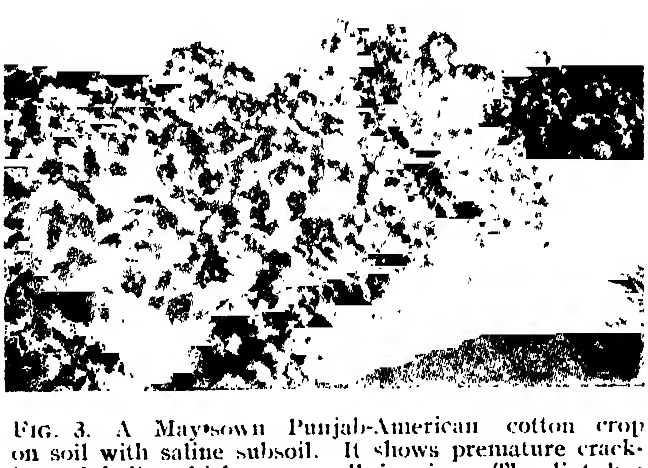

Fig. 3. A May-sown Punjab-American cotton crop on soil with saline subsoil. It shows premature cracking of bolls which are small in size. The lint has not fluffed out from *tirak*-affected bolls.

appeared as usual. Although the onset of flowering was delayed by about a week in the June sowing, flowering activity was completed in the two cases at about the same time. In the June sowing the number of flowers per plant was smaller but the proportion of flowers forming bolls was greater. Although the arrival of the crop was delayed by a few days in the June-sowing there was little difference in the time of termination of the crop in the two cases. The June-sown crop did not also require a late irrigation which would have interfered otherwise with the sowing of wheat.

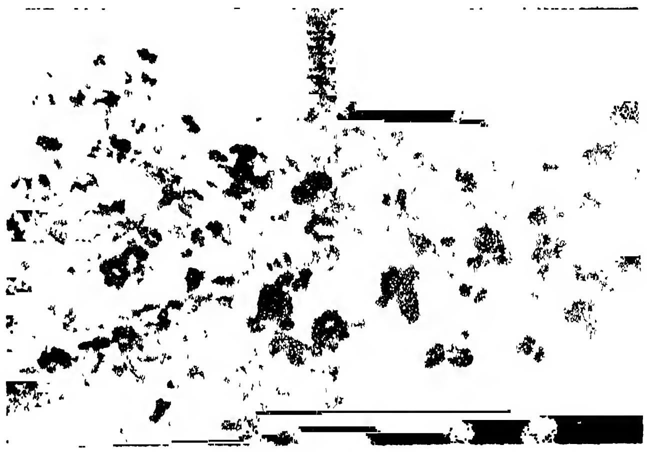

Fig. 4. A June-sown Punjab-American cotton crop. *Tirak* symptoms did not develop even though the crop was grown on a soil with saline subsoil. Notice the big size of the bolls from which the cotton has fluffed out. There was no drooping of leaves.

One serious drawback in the June-sown crop was, however, the reduction in the number of bolls. Thus although *tirak* was remedied the yield per acre diminished especially in normal seasons in a good land. This defect was, however, effectively remedied by increasing the number of plants per acre by closer planting. Cotton seeds were always drilled at a distance of 3 feet in the Punjab irrespective of sowing time and the plant to plant distance was generally kept at 1½ feet. The importance and the necessity of steadily increasing the plant number per acre with delayed sowings was demonstrated by properly designed experiments. The yields from June-sowings with closer spacings were found to be higher than the May-sowings with normal spacing in majority of experiments in all American cotton growing districts. Very late sowing was, however, undesirable on account of a considerable decrease in bearing which could hardly be compensated by any reasonable degree of close spacing and also on account of *Jassids* which would cause serious damage to late sown crop in a *Jassid* year.

Fixing the optimum sowing periods

A cultivator cannot sow all his cotton in a single day. Cotton sowing have to be distributed over 2, 3 or even 4 weeks depending on the availability of irrigation water, the area to be sown and other facilities.

The optimum sowing periods for the commonly cultivated strains of American cottons in the different parts of the Punjab and later in Sind were deter-

mined by a large number of field experiments designed on modern statistical lines. The sowing period of 30 days duration during which highest yields were obtained was taken as the optimum sowing period. Optimum sowing periods were found to differ in the various localities in the Punjab as well as in Sind.

There was also found a varietal difference as regards response to sowing dates. Variety 289F/43 did not perform well in central Punjab when sown later than the middle of June on account of undue reduction in vegetative growth and bearing. Varieties 289F/124 and 289F/K25 performed still more poorly when sown in early June. On the other hand, the same varieties performed well when sown in June in the south-western tracts. Finally two schedules were prepared for the guidance of the cultivator- one indicating the best sowing period for different localities and for different strains in each locality and the other indicating the row to row distance, the plant to plant distance and the seed rate for each week of the sowing period.

AN ESTIMATE OF THE BENEFIT DERIVED BY LATE SOWING

The large commercial farm of the British Cotton Growers' Association at Khanewal in the Punjab was the first to try out the new practice of late sowing with close spacing from 1940 onwards. The cotton crop at this farm suffered frequently from *tirak* in spite of a very high standard of farming practice. About 90 per cent of the total average under cotton used to be sown in May before 1940.

During the seven years of the adoption of this improved practice the crop has not suffered by any appreciable extent from *tirak,* although 1941 and 1946 were partial *tirak* years on account of unusually hot and dry weather during the fruiting period. The relevant yield figures are given in the Table below.

The June-sown crop yielded on an average about two and a half maunds more seed cotton per acre for the period 1940-46. The period of seven years may be regarded sufficiently long for such an estimate of benefit as the seasonal effects on yields may be expected to average out during this period. Taking the average price of seed cotton during this time as Rs. 15/- per maund this farm derived annually an extra benefit of about Rs. 60,000 from their 1,600 acres under cotton for the last seven years. Thus the total benefit derived by this farm *alone* amounted to a sum larger than that expended on the scientific investigation under consideration. The benefit accruing from the application of this improved practice over two and a half million acres of cotton in the Punjab and Sind, can thus be easily calculated.

MAY SOWN CROP

	1933	1934	1935	1936	1937	1938	1939	Mean
Yield of seed cotton in md. per acre ...	12·4	10·56	8·06	12·76	7·77	7·42	3·65	8·95

JUNE SOWN CROP

	1940	1941	1942	1943	1944	1945	1946	Mean
Yield of seed cotton in md. per acre ...	14·56	9·75	16·50	9·05	5·30	11·5	13·0	11·38

Notes and News

GEOPHYSICAL PROSPECTING FOR MANGANESE

Geophysical prospecting for manganese ore has been carried out by the Survey Research Institute near Ramtek in Central Provinces during December 1940 to January 1941 by the Gravimetric method and in January 1947 by the magnetic method. More than half of the Indian output of manganese ore is extracted from C. P. which is a repository of some of the finest manganese ore deposits in the world. In the systematic survey for the location of new ore-beds in the alluvial area of Parsoda, about 1½ miles east of Ramtek in Nagpur District, it is found that manganese occurs in this area in two ways—in reef and in boulder form. In the latter form, boulders range in size from *rori* stones to fairly large stones embedded in shallow alluvium. The reef is more compact, but being associated with the Archean rocks which are considerably folded, is rather elusive and its thickness, width and shape keep on changing all the time. At Mansar mine (on Mansar Hill) its breadth is 100 feet and extends a long way from the hill to the flat ground. It is concluded that in alluvial areas, where no out-crops of rocks are available to indicate what is below, the gravimetric and magnetic methods can save expensive sinking of random pits by giving valuable preliminary indications about the configuration and depth of the sub-surface body. The axes of maximum gravity and maximum magnetic anomaly fall near the sub-alluvial outcrop of the ore-body. A torsion balance observation takes about 2 hours per station and is a slow process, but the magnetic variometer hardly takes two minutes. Modern static gravimeters are also very rapid in operation. The proper sequence is to cover the ground initially with magnetic traverses and gravimeter and then use torsion balance for confirmation. This is the first attempt at geophysical prospecting for manganese ore in India (see *Mem. Surv. Res. Inst.*, *1*, No. 1, 1947).

B. M.

PROBABILITY OF MAKING ATOM BOMBS WITH LEAD AND OTHER ORDINARY ELEMENTS

Science et L'Avenir (Science and the Future —published in Paris) of December 15, 1947, discusses the possibility of preparation of Atom Bombs with ordinary elements like lead. The basis of the discussion is the discovery of the phenomenon of tri- and quadrifission of uranium nuclei by a Chinese pair, Tsien-san-Tsiang and his wife Ho Zah Wei, working in the Institute of Nuclear Chemistry of Prof. Joliot-Curie in the Collège de France. The photographic technique was used by them for the detection of triple and quadruple fission. It may be recalled that the idea of multiple fission was discussed by Prof. M. N. Saha in his theory of Solar Corona in 1941 (see Science and Culture, 7, p. 247).

Prof. E. O. Lawrence, discoverer of the Cyclotron, in discussing high Energy Physics in a Silliman Lecture describes how with the aid of the 184″ Synchro-cyclotron of the Radiation Laboratory, Berkeley, California, high energy protons (100 mev), deuterons (200 mev), α-particles (400 mev), and C^{+12} have been produced, and made to bombard prepared targets.

It reported that lead was fissioned by bombarding the latter with very fast particles. Since there is not much difference in the masses of uranium (235) and lead (207) it is expected that the energy released in the fission of lead and uranium will be of the same order of magnitude.

To effect the fission of lead (207) with the aid of cyclotron of great power one has to use very fast projectiles of mass equal at least to that of helium nucleus but not exceeding that of carbon nucleus. The only practical means of getting these projectiles is by splitting other nuclei. The classical fission of uranium gives two projectiles of mass of the order of 100.

Now it is found that the triple splitting of uranium gives projectiles of mass lying between 50 and 70 and the quadruple splitting of uranium lowers the mass of the projectiles to 45 to 50.

It is possible that the American scientists by carrying researches in this direction may come to a method of bringing in chain reaction in lead by the fission of a mass of uranium. In order that this reaction may take place it is necessary that the particles coming out of the fission of lead nucleus should themselves have sufficiently small mass to effect other nuclear rupture. This means that the fission of the lead nucleus is not a two particle fission but a many particle one as is now seen in the case of uranium.

Under this condition it will be possible to realise atom bomb containing only 3 to 4 grammes of U(235) used to start the reaction and the rest of the charge will be made up of lead conveniently purified.

MESONS PRODUCED IN THE LABORATORY

MESONS were known to exist only in cosmic radiation provided by Nature. Uptil a few months back all attempts to produce them in the laboratory proved futile. It is now reported that such particles have been produced with the help of the 184″ cyclotron of the Radiation Laboratory at Berkeley, California, U.S.A. It was observed that mesons were produced when α-particles accelerated upto an energy of 400 mev were allowed to impinge on a target of carbon. The paths traversed by these mesons were then bent in a magnetic field and finally the mesons were allowed to fall on photographic plates which were shielded from other radiations coming straight from the target. The magnetic field separated the positive and negative meson beams from each other and one of the beams was allowed to fall on a photographic plate for detection. The arrangement was such that protons, deuterons or any other heavy particle could not impinge on the photographic plates.

The production of mesons could not be observed with either 200 mev deuterons or 100 mev protons. With 400 mev α-particles mesons were produced at a threshold energy of 370 mev, the number of mesons increasing with increase of energy of the particles.

The tracks on the photographic plates were much thicker than those due to electrons and since the arrangement prevented protons or other heavy particles from impinging on the film the only explanation of these tracks was that they were due to mesons. The range and energy of the mesons produced in this way were found to be small being of the order of 5 to 10 mev.

Uptil now only 50 meson tracks have been found and of these 10 tracks have been ascribed to positive mesons. The mass of a negative meson was found out to be approximately 300 *m* and that of a positive meson appeared to have a different value. Some mesons were found to end in the emulsion of the photographic plate, but not a single decay electron track has been detected so far. Some of these mesons were found to end in stars.

It was further observed that by changing the material of the target from carbon to uranium no appreciable change took place in the process of production of mesons.

DRAWN LAMINATED MOULDINGS

THE Council of Scientific and Industrial Research has developed a new process for the manufacture of resin impregenated sheets and boards and drawn laminated mouldings. By this process a large variety of attractive moulded articles can be manufactured which are superior to and more economical than those made from powder mouldings.

Powder moulded products are brittle and break easily on impact whereas drawn laminated mouldings possess an extraordinary degree of toughness and will not break. Also articles possessing intricate shapes can be produced from impregnated sheet fabric because of the inherent properties of laminate materials.

By this new process articles possessing attractive styles, fancy shapes, colours and patterns can be produced. The Council of Scientific and Industrial Research has made ash trays, cigarette cases, shoe polish containers, electrical fixtures, switches, plugs and other similar articles. The manufacturer is thus enabled to cover a wide range of consumer goods from household articles, furniture, decorative objects, building materials, gears, children toys and stationary.

This process utilizes ordinary resins, jute, cotton and other material available in India ; capital investment is about Rs. 200,000/-. The manufactured cost of impregenated laminated moulded articles is very low. Actually the selling price fetched by the mosaic articles in attractive colours and shades produced by this process will be more than from ordinary powder mouldings.

S. S *JALAUSHA*

THE first steamer made in India by Indian labour and with the aid of Indian finance was launched on March 14 last at Vizagapatam by Pandit Nehru, India's Prime Minister. This is in fact a revival of a great industry in India. The Scindia Steam Navigation Company founded in 1919 established a site for ship-building at Vizagapatam in 1941. The total amount invested in the Yard comes to about Rs. 4 crores. The shipyard can now build ocean-going vessels with a maximum length of 550 ft. and a maximum carrying capacity of 12,000 tons cargo.

S. S. *Jalausha* built at this yard is a single-screw cargo steamer having a deadweight capacity of 800 tons on a draft of 25 ft and a length of 415 ft.

Launching the first Indian-built ship, Pandit Nehru said that the industry was so vitally connected with the development of the country that the Government would be obliged to treat it as its own industry and give every facility for its growth.

Mr Walchand Hirachand, Chairman of the Company, asking Padit Nehru to lunch *Jalausha* said "With our vast coastline, extending over 4,000 miles with the strategic position that we occupy in SE Asia, and with the commanding situation which

our country occupies in the Indian Ocean, our responsibility to build a powerful naval defence has immensely increased." Stressing the importance of such raw materials as steel and timber in the construction of a ship-yard, Mr Walchand appealed to the Government to give careful considerations for completion of the Scindia Yard. The Government will have to give necessary financial assistance to shipowners or the ship building industry for this purpose and also encourage indigenous ship owners to place orders for the construction of their ships in their own country.

DELHI UNIVERSITY

To mark the twenty-fifth anniversary of the foundation of the Delhi University, a Special Convocation was held on March 7, 1948 at New Delhi. His Excellency Lord Mountbatten, Chancellor of the University, presided.

Addressing the Convocation, Lord Mountbatten said that India requires pioneers to put through the Government's policy of raising the standard of living of the people. The greatest potential wealth of India lies in the people of India, their skilled labour and the inventive genius which can be trained and developed and made use of for the benefit of the country.

Referring to the many schemes for the benefit of India, His Excellency said "Desert reclamation is another science which can save a large part of India. Tens of thousands of square miles of the deserts of Jodhpur and Bikaner, can be reclaimed ; and I prophesy that within the next 60 years the whole of these vast streches of land will be amongst the most fertile in the world."

To commemorate the silver jubilee of the University *Honoris Causa* degree of doctor of science was conferred on Lord Mountbatten, Sir S. S. Bhatnagar, Sir K. S. Krishnan, and Mr D. N. Wadia ; the degree of doctor of literature was conferred on Pandit Nehru, Maulana Azad, Rajkumari Amrit Kaur, Dr. Zakir Hussain, Rao Saheb S. R. Ranganathan, Dr. K. R. V. Rao, Sir John Sargent, Dr. S. N. Sen, Principal N. V. Thadani and Dr. Mortimer Wheeler ; the degree of doctor of civil law was conferred on Sir B. N. Rao, Sir Tejbahadur Sapru and Sir S. Varadachariar.

UNIVERSITY OF CALCUTTA

Annual Convocation

THE Annual Convocation of the University was held on Saturday the 20th February, 1948 at the Presidency College, Calcutta. His Excellency Sri C. Rajagopalachari, Chancellor of the University presided.

Sri K. M. Munshi, Agent-General of India in Hyderabad, who was invited to address the convocation, referred to the role that Universities should play in the shaping of the future India. "University education" he said "must be the first charge of new India. Our universities are our only hope in the arduous task of building up the economic, intellectual, and spiritual life of our new nation". The universities are no longer factories for turning out lawyers and officers to support British rule, they can no more continue to be the agencies for maintaining the mechanical and commercial system of holding examinations. They have to be the seats of Indian Culture. The universities must be like *ashrams* of old where the student lived, not to have his presence marked, nor to secure a pass but to learn the art of shaping his own life, the art of self-sculpture, by humility, by service and by developing a spirit of enquiry. The quality of our university education must change. India wants to be a democracy and develop democratic virtues, which our young men will acquire if our universities, at an early collegiate stage, insist on an intensive study of subjects of purely cultural interest and make the student responsive to higher values. At the same time our national education must stimulate national productivity.

5,602 new graduates were admitted to the different degrees as against 5,553 in the preceding year, including Sri P. C. Bhattacharya, Sri S. N. Ghosh, Sri A. K. Majumdar, Sri N. K. Sarkar and Sri S. C. Ray who were admitted to the degree of doctor of science and Sri A. K. Chakravorti, Sri S. N. Chaudhuri and Sri J. C. Saha who were admitted to the degree of doctor of medicine.

Sir Devaprasad Sarvadhikari Gold Medal for 1947 was awarded to Prof. P. M. S. Blackett, F.R.S. of the Manchester University *(in absentia)*.

Coates Gold Medal for notable contribution in medical science was awarded to Sri J. P. Basu, Dr. G. Panja and Sri P. De.

Jagattarini Gold Medal, Bhuban Mohini Dasi Gold Medal, Sarojini Basu Medal and *Sarat Chandra Memorial Gold Medal* were awarded to Sri Jogesh Chandra Roy *Vidyanidhi*, Sjkta. Santa Debi, Dr. S. K. De and Sri Tarashanker Bandyopadhaya respectively for their original contributions in Bengali language.

Mouat Gold Medal and *Jubilee Gold Medal* were awarded to Sri P. C. Bhattacharyya and Sri R. N. Chatterjee respectively.

LOW-COST SYNTHETIC GASOLINE PROMISED WITHIN DECADE

LOW-COST synthetic gasoline and oil will be manufactured on a large scale in the United States within the next decade, Dr A. R. Powell, associate director of research of Koppers Company, Pittsburgh, Pennsylvania, predicts in a report to the American Chemical Society.

Asserting that the current demand for liquid fuels far exceeds that of the years immediately preceding World War II and will continue to increase,

Dr Powell states that the search for inexpensive substitutes made from coal, natural gas, and other materials is being pushed aggressively.

"It now appears likely that the synthesis of liquid fuels will prove to be one of the major technical developments in the United States during the next decade."

The production of low-cost synthesis gas from natural gas and cheap grades of coal is probably the most difficult and also the most important problem connected with the synthetic fuels programme, according to Dr Powell, who explains that synthesis gas is the mixture of hydrogen and carbon monoxide that serves as the single major raw material for the Fischer-Tropsch type of synthetic liquid fuel, which was developed in Germany, and may also be employed in the Bergius process as the source of hydrogen needed to convert coal to liquid fuel.

HOMEOPATHIC SYSTEM OF THERAPEUTICS

The Dominion Parliament of India adopted a resolution recently that in view of the fact that treatment by the system of Homeopathy is taken advantage of by so many people, the Government should consider the making of arrangements for the teaching of Homeopathy ; consider the advisability of having post-graduate courses of study and of regulating the profession ; and arrange for the registration of practitioners in order to raise and maintain a uniformity of standards.

It was said that during the rule of British Imperialism the science of Homeopathy had been neglected in India. If recognized by the State, Homeopathy could make a substantial contribution in solving the medical problems of India.

Rajkumari Amrit Kaur, Health Minister said that if it was desired that there should be legislation for the purpose of regulating the practice of this system and for registration of practitioners, the matter would have to be studied carefully. In the U. K. and U.S.A., people practising Homeopathy had a regular course of scientific medicine. If Homeopathic practice was to be regulated in India by legislation, India would also have to adopt some such procedure. A committee would be set up to consider the whole question.

ALL-INDIA INDUSTRIAL AND AGRICULTURAL EXHIBITION

Covering almost every aspect of national life, the All-India Exhibition at the Eden Gardens, Calcutta, is perhaps the biggest of its kind ever organized in this country. Covering an area of about one and a half sq. miles the exhibits include sections on agriculture, industry and their raw materials, banking and insurance, power and transport, health and education, history and archaeology, etc., distributed in 815 stalls and 150 pavillions.

Opening the Exhibition on February 15 last, H. E. Sri C. Rajagopalachari emphasized the urgent need for development of India's agriculture and industry. Exhibitions were intended to present the data required for planning future activity and were not a business proposition. Fundamentally they have an educative function.

Sri Nalini Ranjan Sarker, President, Working Committee of the exhibition also referred to the value of such exhibitions in the onward march of every nation in trade, industry and social progress. He referred to the forthcoming British Industries Fair, and some other big-scale exhibitions held in the U.K. in the post-war period. The B. I. F. has attracted 87 U. K. industries representing more than 3,000 firms. If progressive countries like England, attaches so much importance to the organization of fairs of this nature, in their production drive, it is easy to imagine how urgently we need to organize fairs of this nature at the present stage of our developing economy. Majority of our people have but an inadequate idea about the immense possibilities of our country and how best to exploit them.

In addition to private exhibitors, the Central and Provincial government's Irrigation, Health, Agriculture and Industrial departments, the P. and T. departments, the Railway Board, the Meteorological department, the Patent office, the Army, Navy and Air Forces--where latest defence weapons are displayed--have been allotted space for their interesting exhibits. There are also sections dealing with cultural subjects--fine arts, science, newspaper and periodicals, and national survey.

ATOMIC ENERGY BILL

A bill providing powers to the Government for the control and development of atomic energy in India and the disposal of the relevant raw materials was introduced in the Dominion Parliament recently by Pandit Nehru, the Prime Minister.

The bill aims at control of plant designed or adapted for the production or use of atomic energy, the working or export of fissible substances such as uranium, thorium, plutonium, neptunium, and substances like beryllium and their compounds.

"While every endeavour would be made to keep fundamental scientific discoveries outside the limits of any secrecy provision, it is recognized that information given by foreign atomic energy agencies may have conditions attached to it. In order to ensure secrecy, while members of the Board of

Research on Atomic Energy will be able to have free discussions among themselves, provision has been made in the Bill for security measures which would be necessary".

ANNOUNCEMENTS

The Twelfth Annual Meeting of the Botanical Society of Bengal was held in Calcutta on March 14 last, at which the following were elected office-bearers for the year 1948-49: *President*: Dr K. Biswas; *Vice-Presidents*: Sri S. N. Bal, Mr. A. P. Benthal, Prof. P. C. Sarbadhikari, Prof. J. C. Sen Gupta and Prof. G. P. Majumdar (*Ex-officio*); *Treasurer*: Dr I. Banerji; *Hony. Secretaries*: Sri A. K. Ghosh and Sri A. K. Chakravorty. Sri Jogesh Chandra Ray *Vidyanidhi*, was elected an Honorary Member of the Society.

The Hony. General Secretary, Indian Medical Association, 23, Samavaya Mansion, Corporation Place, Calcutta 13, invites applications for four Research Fellowships of the value of Rs. 250/- each per month.

Dr P. Venkateswarlu who is now working with Prof. Niels Böhr as an International Research Fellow has been elected to a post-doctoral research fellowship of the value of 3,500 dollars per annum at the University of Chicago. Dr Venkateswarlu was admitted to the degree of doctor of Science for his thesis on "Molecular Spectra of Halogens".

Sri A. K. Ghosh, lecturer in Botany, Calcutta University, has been appointed Registrar, Bose Research Institute, Calcutta. A man of wide culture with organizing abilities, Sri Ghosh is known to our readers by his writings in this journal of which he is an Associate Editor. He is also an editorial collaborator of the Calcutta Geographical Review and the Journal of the Science Club, Calcutta. He was recently awarded the *Bronze Medal* of the Mining, Metallurgical and Geological Institute of India of which he is a member, (See *Science and Culture* March, 1948 p. 381); and his recent investigation on microfossils as an aid to the age determination of Sedimentary strata have thrown new light on the 'Age of the Saline Series in the Salt Range, Punjab' (*ibid* p. 376)

BOOK REVIEWS

Harvey Cushing—By John F. Fulton. Published by Blackwell Ltd. Oxford. Price 30*sh* net.

The lives of eminent men are not only highly interesting and illuminating but also a source of inspiration. This description can be rightly applied to this biography of Harvey Cushing, written by John F. Fulton.

Born in a family, where the tradition was distinctly "medical" being preceded by three generations of medical men in a line, it is not surprising that he reached the very top in his profession. Harvey Cushing, the youngest of Dr Kirke Cushing's ten children, had to conduct himself properly under the stern guidance of his aged father. At Yale, where he graduated, Cushing came early under the influence of Prof. Chittenden and also became intimate friend of Joslin Graham Lusk and Lafayette Mendal, all of whom later on made their marks as eminent physiologists. As a matter of fact he nearly came to become a biochemist, only the influence of his family made him decide in favour of joining instead the medical school at Harvard. From the very beginning he did extremely well at Harvard, where he came under the influence of many eminent scientists. It was here as a medical student that he made his first contribution, in collaboration with Codman, to the technique of surgery, by working out a system of continuous recording of temperature, pulse and respiration during the administration of volatile anaesthesia. This enabled the surgeon and the anaesthetic to tell at a glance the condition of the patient.

After graduation Cushing came to John Hopkins Hospital at Baltimore as Halstead's assistant and the biography including extracts from his daily diaries and letters unfolds the absorbing story of his rapid rise to fame, at first a general Surgeon and later on by 1908 as "brain" Surgeon. The book also gives an interesting account of his wonderful work on the physiology and pathology of the pituitary gland.

Harvey Cushing in his early days visited and worked with most of the well-known surgeons, physiologists and eminent men of those days like Kocher, Riverdins, Ludwig, Sahli, Asher, Mosso, Sherrington and later on came intimately in contact with most of the eminent scientists of his time like Osler (whose biography he wrote), Reed, Welch, Pavlov, Klebs, Crile, Frohlich, Head, Horsley, Lister, Panlesco, Gajal, Rolleston and others. The biography contains many intimate description of these men from Cushing's diaries and letters, which are highly interesting and illustrative.

Harvey Cushing's life is the life of a successful scientist, who approached the subjects of his studies earnestly and overcame the baffling difficulties, which workers in this field find constantly cropping up, by a combination of highest technical skill with profound knowledge of physiology and pathology.

B. B. S.

Environment, Tools and Man—By D. A. E. Garrod. Cambridge University Press, 1946. Pp. 30. Price 1s. 6*d*. net.

In her inaugural address as Disney Professor of Archaeology, Professor Garrod emphasises a certain point for which archaeologists should feel rightly grateful to her. There has grown up a tendency among prehistorians to deal too much with the anatomical peculiarities of tools left by ancient man. They are likely to lose sight of the wood for the trees. For, after all, tools are of use only in so far as they reveal to us the *life* of man. Miss Garrod says that for this reconstruction we must lay under contribution all that the physiographer, the paleobotanist and the paleontologist have to say with regard to the physical and organic surroundings of ancient man. A knowledge of modern stone or bone using tribes, their technique and the function of different tools, should also supply us with necessary materials. And with all these before us, using our scientifically trained imagination, we shall be able to reconstruct ancient man's life with some degree of confidence.

In course of her address, Professor Garrod refers to Professor Gordon Childe, and complains that even he has, in one of his more recent books somewhat lowered the role played by mankind in relation to nature. Man, according to her, is the conqueror of nature, his will dominates the scene, rather than his life being dominated by nature. This is a point where the reviewer feels more in sympathy with Childe's views than with those of Professor Garrod. For, after all, what does 'conquest' imply? It means no more than this that through more careful observation of nature's working, man is able to play upon certain subtler forces or combination of forces and succeeds in turning them to his own advantage. Nowhere does he transgress, or anyhow go beyond, nature's laws. His will resolves itself into nothing more than a freedom of choice ; and even that for purposes which are biologically determined. Over his own biological needs, which form the mainspring of his behaviour, both in its personal aspect and its crystallized aspect, which means culture, he has hardly any choice at all. After all it is nature's own laws which operates in the object as well as the subject.

Barring this aspect of the lecture, one would heartily agree with the rest of Professor Garrod's plea for a more wholesome and complete use of imagination in the workshop of the archaeologist.

N. K. R.

The Elements of Physical Chemistry—By Samuel Glasstone. Published by Van Nostrand Company, Inc. New York, 1947. Third printing. Pp. i to vi + 695. Price 25*sh*. net.

The reviewer has not come across any other book on elementary physical chemistry so elegant and lucid as the one under review. This remark applies to all the nineteen chapters into which the subject matters have been distributed. Particularly, the ideas of the wave nature of electrons, valency, resonance and the modern concept of acids and bases have been nicely introduced. In the presentation of the abstract principles simple physical ideas have been incorporated and in this respect the author has evidently followed the novel procedure adopted in the highly instructive *Journal of Chemical Education*, to which alone the author has given complete references. These will be of great service to the students and teachers alike. The large number of worked-out problems in the text and the exercises and review questions at the end of each chapter are so chosen as to make the implications of the relevant subject matter at once clear to the reader. The table of physical constants and of logarithms at the end of the book is a necessary and welcome feature.

The fundamental units could have been discussed in a separate chapter in order to dispel confusion in many and to acquaint readers with the inter-relationships. The adsorption isotherm given by equation (56·10) should have borne the name of Freundlich. An obvious printing lapse on page 140 line 13 has been noted.

S. K. M.

Heaviside's Operational Calculus Made Easy—By Dr T. H. Turney, Ph.D., M.Brit., I.R.E. Published by Chapmann & Hall Ltd., London. Second Edition. Price 10*s*. 6*d*.

At the end of the preface of the book in the first edition the author states that "this book will interest the practising engineers and also appeal to the students who would like to feel at home on the subject of transients and impulses". With little mathematics like honey for tea the author wants to take them a long way in the study of the problems on transients and impulses. That he has been successful to do so and add further interest to the subject can not be doubted.

He starts with inductance and capacitance and a voltage wave—a steady one being a particular case and shows that p obeys the ordinary laws of algebra and then proves that

$$\frac{1}{p} = t \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (1)$$

means integration and interprets

$$\frac{1}{p^n} = \frac{t^n}{\lfloor n} \quad . \; . \; . \; . \; . \; . \quad (2)$$

Helmholtz and Kelvin's Laws are deduced with the same simplicity and clearness. Heaviside's expansion follows as a sequel to the above. The dis-

cussion on wave propagation on cables is crystal clear and lucid.

In Chapter VII any applied voltage is divided into exponential components, not sine components in Fourier's integral; with the help of these the author shows that the indicial admittance to unit voltage is

$$A(t) = \int_{\odot}^{\infty} \frac{e^{-pt}}{p\, z\,(p)}\, dp \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

"If $1/p$ is the spectrum of Heaviside's unit voltage (page 73), then if we take a circuit having an operator $Z\,(p)$ for its impedance and apply unit voltage to it, the spectrum of current is $\frac{1}{pz(p)}$ and the complete current is given by (3).

Thus Dr Furney is able to deduce Bromwitch complex integral formula without the help of complex functions. The deviation of Carson's integral from (3) at one stroke, we are at liberty to change the functions

$$\frac{1}{t\, z\,(t)} \text{ and } A(p)$$

This transaction may not appeal to trained mathematicians without formal proof.

As stated in the opening paragraph the book is eminently suitable to a beginner who possesses rudimentary knowledge of differential and integral calculus and electricity. One can read the book page after page with absorbing interest till he comes to the end of chapter VII where the Heaviside story ends.

In order to avoid complex algebra, the latter part of the book is written in a semi-physics mathematical manner. This might lead to difficulties to a beginner. For vigorous proofs the author should have references to such books as Carslaw and Jaeger's Operational methods with complex algebra.

R. N. G.

LETTERS TO THE EDITOR

[*The Editors are not responsible for the views expressed in the letters.*]

THE HERZBERG BANDS OF THE O_2 MOLECULE OBSERVED IN EMISSION ($^3\Sigma u^+ \rightarrow {}^3\Sigma g^-$).

OXYGEN produced by heating $KMnO_4$ crystals was excited by high frequency (750-850 Kc./Sec.) discharge (out-put power less than 10 watts) and the spectra photographed both in the visible and in the ultra-violet regions by the Fuess Glass Prism spectrograph and the small (Baby) Hilger Quartz Prism spectrograph respectively with a view to study the O_2^+ molecule bands mainly. On examining the plate in the ultra-violet region, however, the following Herzberg bands of the O_2 molecule (observed by Herzberg in absorption) were also detected.

S. No.	Visual Intensity	Degradation	λ observed	Remarks
1	4	Diffused	2591·6	
2	2	Diffused	2643·7	
3	7	Diffused	2692·7	It coincides with an OH band.
4	4	Violet (doubtful)	2742·4	
5	5	Red	2771·4	
6	4	Red	2856·2	
7	7	Violet (doubtful)	2884·8	It coincides with a prominent band attributed to the O_2^+ molecule.

The observation of these Herzberg bands in emission aroused interest because it was for the first time that these bands were observed in emission: and, furthermore, this observation proved the existence of the $^3\Sigma u^+$ state of the O_2 molecule whose very existence is not recognized as yet.*

To be therefore definite on this point the ultra-violet spectrum was again photographed on the Medium Hilger Quartz Spectrograph which gave greater dispersion. On examining this plate many more of the Herzberg bands have been found. Besides, some new bands have also been observed which on a preliminary analysis appear to belong to this Herzberg system of the O_2 molecule.

Further work on this point is in progress.

My thanks are due to Prof. R. K. Asundi of the Benares Hindu University under whose guidance the

* Herzberg regards the $3\Sigma u+$ state as the final level of his absorption bands but others do not believe in it.

work has been done, and to Mr Ram kishan Agrawal, D.A.V. College, Kanpur, for his help in preparing the manuscript.

LALJI LAL

Department of Physics,
D.A.V. College, Kanpur, (India).
16-12-1947.

β-PHENYL-LAEVULIC ACID

BOTH α-phenyl-, and γ-phenyl-laevulic acids are known for a long time. β-phenyl-laevulic acid does not, however, seem to be have been described before. Two independent methods are now recorded for the preparation of β-phenyl-laevulic acid in quantity.

Bromophenylacetone[1] was condensed with ethyl sodio-malonate in presence of benzene and the product thus obtained on hydrolysis with alcoholic potash yielded *α-carboxy-β-phenyl-laevulic* acid, m.p. 162-165° (decomp.). The latter on heating looses carbon dioxide with the formation of *β-phenyl-laevulic acid*, m.p. 98° which readily formed a *semicarbazone*, m.p. 224°.

Phenylacetone also reacts with ethyl bromoacetate in presence of sodium-*iso*propylate[2] giving an excellent yield of *ethyl β-phenyl-laevulate*, which forms a colourless refracting liquid, b.p. 133°/4 mm. This on hydrolysis with alcoholic potash affords *β-phenyl-laevulic acid*, m.p. 98° (*semicarbazone*, m.p. 224°). On oxidation with sodium-hypobromite it gives phenyl-succinic acid[3], m.p. 166-167°.

Ethyl β-phenyl-laevulate smoothly condenses with ethyl bromoacetate and zinc with the formation of a *lactonic ester*, b.p. 162°/4 mm.

Further work is in progress.

I have much pleasure in expressing my indebtedness to Prof J. C. Bardhan for facilities and encouragement.

(Miss) DEBI MUKHERJI

Khaira Laboratory of Organic Chemistry,
University College of Science and Technology,
Calcutta. 3-1-48.

[1] Emde and Runne, *Arch. Pharm.*, 249, 361, 1911.
[2] Suter and Weston, *J. Amer. Chem. Soc.*, 64, 534, 1942, also Tiffeneau and Levy, *Bull. Soc. Chim.*, [4], 33, 759, 1938; Levy and Jullien, *ibid.*, 45, 941, 1929.
[3] Higson and Thorpe, *J. Chem. Soc.*, 89, 1472, 1906.

EXISTENCE OF *RECTAL CAECUM* IN A TELEOST LIKE *NOTOPTERUS CHITALA*

THE *rectal caeca* in birds are common and the variation and suggested functions have been formulated by many workers even quite recently. *Rectal caeca* have been recorded in Selachians by many workers including Crafts[1] who dwelt on the subject exhaustively and comparatively, not only with the morphology but also included their physiology.

During our study of the morphology of the digestive tract of the fresh water and estuarine fishes of Bengal, we came across with the *rectal caeca* of the species of *Notopterus chitala*, the size of which is quite considerable and the existence of such a structure is rather rare. Howes[2] recorded *rectal caeca* in three teleostian species, but the sizes of the *rectal caeca* of each of these is insignificant. Our specimen of *Notopterus chitala* measures 36″ in body length and the size of its *rectal caecum* 3·5″ in length and the circumference of it is ·9″. It is situated at the lower part of the intestine and connected to the dorsal side of the rectum. So far as our knowledge goes, there is no record of the existence of Indian teleost to possess this caecum. In an allied species, *Notopterus notopterus* the *rectal caecum* is absent.

RABINDRA NATH BHATTACHARYYA

Fish Laboratory,
Zoology Department,
Calcutta University,
5-1-1948.

[1] Crafts, *Proc. Zoo. Soc. Lond.*, pp. 101-188, 1925.
[2] Howes, *Linn. Soc. Jour. Zoo.*, 23, 381, 1890.

NUTRITIVE VALUE OF *VANASPATIS*

DUE to the shortage of butter fat, hydrogenated oils (*vanaspatis*) have been increasingly used in recent years as a source of fat in human dietary. Its resemblance with *ghee* in texture and its comparative cheapness has rapidly replaced *ghee* in the dietary of lower and middle classes. Inspite, however, of its every day increased use and the unprecedented expansion of its manufacture, very little is known about the metabolic behaviour of food components as affected by the inclusion of *vanaspatis* prepared from different vegetable oils. Investigations to study the influence of some of the commonly available vanaspatis and their parent oils (raw and refined) as compared to cow *ghee* (Butter fat) on protein, calcium and phosphorus metabolism, were undertaken. Observations on protein metabolism, are presented here.

Ninety healthy adult rats were divided into 15 groups of six each. They were fed a fat free basal ration to which fat was added from different sources *e.g.*, raw and refined groundnut, sesame, cotton seed oils, three preparations of hydrogenated groundnut oil (*Dalda* m.p. 36°C, *Dalda* m.p. 40 to 42°C and First quality), two preparations of hydrogenated *til* oil (*Temple* and *Rajhans*), two preparations of hydrogenated cotton seed oil (*Binaula* and *Kotogem*) and cow *ghee*, the latter was used as a standard for purposes of comparison. One group of fats was maintained on fat-free diet, as a negative control.

The basal diet consisted of, dextrinized starch 59 per cent, casein (alcohol and petroleum ether extracted) 24 per cent, yeast (petroleum ether extracted) 8 per cent, McCollum and Davis salt mixture 4 per cent. 95 parts of the above diet were mixed with 5 parts of *ghee*, *oil* or *vanaspati*. In addition to the diet (15-18 gms. daily per rat), each animal also received 5 microgram carotene and 1 microgram calciferol. The supplement of the cow *ghee* group was equated.

Metabolism trials were conducted according to the standard procedure adopted in this laboratory. The average results of six animals showing digestibility coefficient and biological value of protein are given in table 1.

TABLE 1

Groups of rat indicated by nature of fat.	*True digestibility coefficient of protein.*	*Biological value*
Fat free	67	45
Cow *ghee*	91	73
Groundnut oil raw	90	54
Groundnut oil refined ...	91	60
Daldh Vanaspati (m.p. 360°C) ...	93	59
Dalda (m.p. 40-42°C) ...	90	58
First quality (m.p. 40-42°C) ...	84	52
Til oil raw	90	59
Til oil refined	92	56
Temple (m.p. 41-43°C) ...	88	52
Rajhans (m.p. 42°C) ...	89	57
Cottonseed oil raw ...	90	51
Cottonseed oil refined ...	86	55
Binaula (m.p. 37-40°C) ...	89	61
Kotogem (m.p. 41°C) ...	90	55

It will be observed that the digestibility coefficients of protein of cow *ghee* group do not markedly differ from various oil and vanaspati groups, except in the first quality, but the biological value of protein is definitely higher than any of the oil or vanaspati groups. If the biological values of vanaspati groups are compared with the corresponding parent oils, no significant difference was observed. It will, however, be observed that the digestibility coefficient is decreased by 26 per cent and biological value by 38 per cent on a fat-free regime as compared with the cow *ghee* group.

Hartwell[1, 2], Reader and Drummond[3] and Hassan and Drummond[4] showed that an adequate provision of B-vitamins is essential for the successful utilization of dietary protein. Boutwell *et al*[5] also indicated that the requirements of B-vitamins were enhanced when diet containing corn oil was fed.

Experiments carried out in this laboratory (*unpublished*) showed evidence of extensive alopecia in the second generation of all the vanaspati groups, even when the basal diet contained 8 per cent yeast, whereas the animals of *ghee* group were not affected. In experiments with chicks vitamin B deficiency symptoms like leg weakness were also evident in the vanaspati groups. In order to study the effect of supplementation of B-vitamins, the group of rats received raw groundnut oil and vanaspati (m.p. 36°) were supplemented with pure B-vitamins. Each rat received a daily dose of solution containing 30 microgram Thiamine hydrochloride, 30 microgram pyridoxin, 50 microgram riboflavin, 100 microgram calcium-d-pantothenate and 1 mg. nicotinic acid. Results are given in Table 2. (average of 6 animals).

TABLE 2

Group of rats	True digestibility coefficient	Biological value
Ground nut oil Raw+B-vitamins	92	60
Vanaspati (m.p. 36°C)+B-vitamins	94	67

It will be observed that the biological value in the groundnut oil group rose by 11 per cent and in the vapaspati (m.p. 36°C) by 14 per cent.

Details will shortly be published elsewhere.

N. D. KEHAR
R. CHANDA

Animal Nutrition Section,
Indian Veterinary Research Institute,
Izatnagar, 7-1-1948.

1 Hartwell, G., *Biochem. J.*, *16*, 78 and 825, 1922.
2 Hartwell, G., *Ibid.*, *22*, 1212, 1928.
3 Reader, V. and Drummond, J. C., *Ibid.*, *20*, 1256, 1926.
4 Hassan, A. and Drummond, J. C., *Ibid.*, *21*, 653, 1927.
5 Boutwell, R. K., Geyer, R. P. and Hart, E. B., *Fed. Proc.*, *4*, 152, 1945.

BASIC NITRATES OF URANIUM

THE authors have studied the system uranyl nitrate—caustic soda by thermometric method. The thermometric titration of uranyl nitrate solutions with caustic soda and *vice-versa* indicate the existence of the basic nitrate $4UO_2(NO_3)_2UO_2(OH)_2$ in the concentration range (0·02912 to 1·1648 M uranyl nitrate).

We have however observed no break in the temperature concentration curve corresponding to uranyl nitrate: caustic soda equal to 1:1, although Jolibois and Bossuet[1] reported the existence of the compound from radiometric study and supported by Flatt and Hess[2]. The uranates $Na_4U_7O_{23}$ and Na_2UO_4 are also indicated in the temperature-concentration curves. But it is to be noted that other physical methods do not indicate the formation of the uranate Na_2UO_4. The break corresponding to the normal hydroxide appear exactly at the point uranyl nitrate: caustic soda equal to 1:2.

Our results are in agreement with those observed by Guiter[3]. But the formation of the basic nitrate $3UO_2(NO_3)_2 . 2UO_2(OH)_2$ as observed by him in his *p*H-concentration curves are not indicated in our temperature-concentration curves. This is due to the fact that Guiter has observed the formation of the basic nitrate $3UO_2(NO_3)_2 . 2UO_2(OH)_2$ only in hot solution and as we have used all solutions at room temperature (22-25°C) it is not expected to be indicated in the temperature-concentration curves and probably the basic nitrate $3UO_2(NO_3)_2 . 2UO_2(OH)_2$ exist only in hot solution. Thus it is quite evident that the thermometric method indicates not only the existence of known basic nitrates and uranates as observed by other physical methods but also give clear indications of the formation of normal hydroxide $UO_2(OH)_2$ and the uranate Na_2UO_4

Further work on the basic nitrates of uranium are in progress.

Our best thanks are due to Prof. P. B. Sarkar, for his helpful suggestions and all laboratory facilities during the progress of the work.

BARUN CHANDRA HALDAR
GURUPRASAD BASU CHOUDHURY

Chemistry Department,
University College of Science & Technology,
Calcutta, 6-2-1948.

[1] Jolibois and R. Bossuet, *Compt. Rend.*, 174, 1625-8, 1922.
[2] R. Flatt and W. Hess, *Bull. Soc. Chim. de France*, 1460, 1934.
[3] H. Guiter, *Bull. Soc. Chim. de France*, 403, 1946.

VITAMIN B₁ CONTENT OF SOME AYURVEDIC DRUGS

WHILE searching for rich source of vitamin B_1, our attention was directed to some Ayurvedic drugs whose nutritional and biochemical properties have not yet been explored. According to Ayurvedic mode of treatment some *Aristas* are used in cases of dropsy and beri beri and the method of their preparation is as follows:

Decoction is made of indigenous drugs by boiling with water. Old molasses is added to it and the whole material is kept in closed earthen jar and allowed to ferment by wild yeast and other organisms present in molasses. After few months the jar is opened and the liquid is filtered and ready for use.

Since these *Aristas* are prepared by fermentation process, it was expected that they may contain a large store of vitamin B_1 and investigation was, therefore, carried out in this line. The results of analysis of some *Aristas* received by courtesy of some local Ayurvedic *Ausadhalayas* is given in table I. The vitamin B_1 content was measured by the method adopted by Basu and Malakar[1] with a slight modification.

TABLE I

Name of *Aristas*	Vitamin B_1 content in μg. per 100 c.c.
Draksharista	25 μg.
Asokarista	20 μg.
Dasamuladyarista	30 μg.
Suskamuladyarista	20 μg.
Aswagondharista	18 μg.
Punarnabarista	25 μg.
Parthadyarista	25 μg.
Balarista	40 μg.
Mustakarista	22 μg.

Some medical herbs which are used in Ayurvedic medicines were also analyzed for their vitamin B_1 content and the results are shown in table II.

TABLE II

Name of the herbs		Botanical name	Vit. B_1 content in μg. per 100 gms.
Gulancha	(raw)	*Tinospora cordifolia*	5·0 μg.
Satamuli	(„)	*Asparagus racemosus*	2·0 μg.
Punarnaba	(„)	*Boerhaavia repens* ..	210·0 μg.
Aswagandha	(dry)	*Withania somnifera*	130·0 μg.
Asoka	(„)	*Saraca indica* ..	50·0 μg.
Berela	(„)	*Sida rhombifolia* ..	54·0 μg.
Arjun	(„)	*Terminalia arjuna* ..	100·0 μg.
Raddish	(„)	*Raphanus sativus* ..	200·0 μg.
Alkushi	(„)	*Mucuna pruriens* ..	300·0 μg.
Yasthimadhu	(„)	*Glycyrrhiza glabra* ..	120·0 μg.
Bahera	(„)	*Terminalia belerica* ..	100·0 μg.
Talmakhna	(„)	.. .. ..	80·0 μg.

H. C. DE
M. C. MALAKAR

Nutrition Research Unit (I.R.F.A.),
Biochemical Laboratory,
Dacca University,
11-2-1948.

[1] Basu, K. P. and Malakar, M. C., *Ind. Jour. Med. Res.*, 34, 39, 1946.

Psychology and Educational Science

Principles of Educational Reconstruction

ZAKIR HUSSAIN

DR Hussain holds that the process of mental culture or education shows a striking resemblance to the process of the growing development of the human body. As the body, from its embryonic beginnings, grows and develops to its full stature by means of suitable and assimilable food, movement and exercise, in accordance with physical and chemical laws, so does the mind grow and develop from its original dispositions to its full evolutionary cultivation by means of mental food and mental exercise according to the laws of mental growth. This mental food is supplied to the mind by the cultural goods of the society and the growing mind, as surrounded by the treasures of culture, takes hold of them and uses them at first unconsciously and later more and more consciously for its gradual development.

Dr Husain observes that we should distinguish between the informational and educational value of the various subjects of study and should look upon the school as a place of educating the mind and not of amassing ill-digested information. So he recommends that in the early years of the school system we should introduce the goods corresponding to the dominant psychical characteristic of the early age-period namely, practical activity and quotes Goethe who said "with hand-work must begin all life, all work, all art." Dr Hussain thinks that the mind gets its culture when it is gripped by cultural values embodied in appropriate cultural goods, when it grasps them, understands them, reconstitutes them, creates them. So "our educational institutions from the Basic Schools to the University will all have to be places of such works.'

Agricultural Sciences

Urgent Agricultural Problems of India After Partition

KALIDAS SAWHNEY

THE address deals primarily with the problems of Indian agriculture after partition and some suggestions for their solution. The Indian farmer always aims at the production of food crops without paying much attention to crop rotation, growing of fodder crops, dairy and poultry farming, fruit and vegetable cultivation, etc. Irrigation facilities being limited he has to depend on the vagaries of natural rains. Added to these are bad soil management, inadequacy of manures and good seeds. Moreover, the farmer is unarmed against various pests and diseases. Proper training in the scientific methods of agriculture is entirely lacking.

War has for various reasons focussed greater attention to the development of agriculture, and a system of co-ordinated planning. To meet the requirements of a balanced diet of an increasing population an all-out effort must be made to step up production of crops including cereals, pulses, vegetables, fruits and of fats and oils, milk, etc.

The provincial plans to implement these ideas have been frustrated as a result of the political and other changes in the country, particularly partition, which has brought unthought-of problems requiring immediate solution. Partition has removed the irrigated wheat and cotton growing tracts of Sind and the Punjab from the Indian Dominion. However, proposed irrigation projects are expected to overcome the deficit. The deficit of 8·96 lakhs of bales of cotton will demand nearly 33 per cent increase in its production. Jute production has suffered greater set back. The demand of jute is all the more necessary to feed the large number of manufacturing concerns situated in India. Migration of population including skilled farmers who had to leave their homes without any means of settling elsewhere, has caused fresh problems of rehabilitation.

The guiding principle should be on the lines proposed by the All-India Congress Committee, *viz.*, the establishment of "real democracy in the country and a society based on social justice and equality". The objective must include national as well as regional self-sufficiency in food production ; achievement of balanced nutrition for all ; rehabilitation of refugees on the land ; improvement of the lot of the farmer ; and larger production of cotton and jute.

To make the plans effective some sort of group cultivation prevalent in many parts of the world must be adopted.

The benefits and feasibility of the various systems of group cultivation in India have been discussed in great detail, and the system of farming by Public Utility Companies similar to those obtained in the case of cash crops like tea, sugar, coffee, cinchona, etc. has been advocated. When dealing with food crops such companies must work under certain conditions. As a successful example of this type of enterprise the details of the experiments undertaken by the Sudan Plantations Syndicate Ltd. deserve attention.

Geology and Geography

Mineral Springs of India

P. K. GHOSH

THE Geological Survey of India carried out field work only during 2 field seasons, 1939-40 and 1940-41, and examined most of the important springs of Bihar and Bombay, and some of those in the United Provinces, the Central Provinces, the Punjab and Bengal. The geology of the area where springs occur was investigated, the flow of the springs and their temperature measured, also their radon content and the radium salts, if any, determined. Samples of water were subjected to chemical analysis and occasionally to spectroscopic analysis for the detection of minute quantities of rare-elements. Certain geological conditions are deduced from the way in which springs are distributed. There are four main broad belts in which the majority of the mineral springs of India occur, *e.g.*, (1) Bihar (*i*) in a belt more or less parallel to the coalfield boundaries, (*ii*) in Rajgir area and (*iii*) in Monghyr area ; (2) along the West Coast of India, in the Ratnagiri, Thana, Kolaba and Surat Districts ; (3) Sind-Baluchistan area ; and (4) the Himalayan belt. There are besides other areas where a small number of springs occur following the general tectonic trends, *viz.*, in the Mahanadi Valley in Orissa, in the Chittagong District in East Bengal. Besides these, springs occur in isolated areas in Assam, at Bakreswar near Suri, Birbhum District, and in Darjeeling District, West Bengal and in Sikkim, and in parts of South India. It is assumed that the springs of the western part of the peninsula are related to the meridional dislocations of the trap country as are known to have affected the peninsula in the Tertiary era, the Bihar ones are related to the East and West post-Gondwana faults, the Himalayan ones are probably related to the local thrust-planes and faults.

As a general rule, the waters emanating from the Archaean terrain, are fairly highly radio-emanative and of low mineral content, those emerging in the basaltic plateau, low in radium-emanation and high in alkaline earths Ca and Mg and the sulphate and chloride radicals. Springs emanating from limestone are high in calcium (Ca) and the bicarbonate (HCO_3), carbonate (CO_3) and also contain varying amounts of the sulphate (SO_4) radicals. Some of the waters emerge cold, others are lukewarm, while still others attain a temperature of nearly the boiling point of water. The highest temperature measured so far is that of the *Surajkund* in the Hazaribagh District which record a temperature of 87°C. The flow of the water has been measured and found invariably larger in the rains and early winter than in the summer, particularly noticeable in cold springs. The origin and the composition of water of cold and hot springs and the constancy of temperature of hot springs are considered. Superheated steam forms over 95 per cent of the volatile gases emanating from magmas; carbon dioxide forms nearly 2 per cent and the remainder is composed of chlorine, fluorine, sulphur (as sulphide and H_2S) and occasional traces of boron and arsenic.

The radio-activity of the waters is due to the presence of radon in solution, the radon being derived from the disintegration of the thorium and uranium bearing minerals present in the rocks through which the water circulates. Most springs and even some well water contain traces of radon, but very few contain radium salts in solution. Temporary and permanent radioactivity, radio-emanative properties and pharmacological action of spring waters are discussed. Many mineral waters, named as medicinal waters contain enough soluble salts and have therapeutical properties ; the chief active ingredients of these waters are the sulphates of magnesium and sodium, bicarbonates and chlorides of alkalies and alkaline earths. The author emphasized on the possibilities of utilizing some of the healing springs by the establishment of mineral water industry and of attractive and well organized spa-resorts and National Parks on the European and American model.

SCIENCE AND CULTURE

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SCIENCE AND CULTURE

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BUREAU OF MINES

WITH the advent of independence in India the attention of the country's Government, both Central and Provincial, has been directed to the proper and efficient development of mineral deposits of India for giving effect to the various schemes of industrialization. Steps have already been taken by the Central Government to formulate a 'National Mineral Policy' for the purpose and work is in progress to set up a 'Bureau of Mines' for this country.

Following up the discussions at the National Mineral Conference convened by the Government of India in January 1947, the Government of India decided to establish a Bureau of Mines—an administrative organization, to standardize conditions of mineral development in India and also to exercise control over the exploitation of the country's mineral assets. The scope of this central organization envisaged powers to frame rules regarding terms and conditions of future leases, application of improved mining methods to ensure conservation of mineral assets, control over exports, collection and compilation of statistical returns, encouragement of domestic utilization of ores and minerals, local processing; providing expert mineral advice and service to all and prosecution of research on mining and fuel.

A well organized laboratory with the latest and most up to date equipment will be attached to this bureau for fundamental and applied research in mineral development, and for the assay of minerals and testing of samples.

Conservation programme is still awaiting solution; wastage of good quality coal has yet to be eliminated; there has been lack of uniformity in the existing laws and licences of the Central and Provincial Governments and mineral resources are being exploited in a manner quite injurious to the country's interests.

The idea of starting an 'Economic Minerals Bureau' for India's industrial progress first emanated in 1945 from the Council of the Geological, Mining and Metallurgical Society of India. The Society was simply expressing the demand of the Indian scientific and industrial public for the establishment of such a Bureau in India. It is gratifying to note that the Government of India realizing the importance of this scheme has now established a Bureau of Mines though on a small scale. Schemes for running such an organization should be very comprehensive and far reaching in character and should always be organized in a way so as to fit in with Indian conditions and peculiarities and to solve Indian problems. Such schemes might bring about fruitful results in the shortest possible time leading to conservation of the mineral resources of this country.

During the last 50 years in India enough high grade raw materials like manganese ores, mica, monazite, ilmenite, bauxite, chromite, and magnesite were allowed to be simply exported or put to improper use or wasted without serving any useful purpose to this country, and it has now become absolutely necessary that such practices should be brought to an end. Lower grade materials should always undergo processing and beneficiation before they can be marketed for better utilization. The U. S. A. has made rapid progress in the matter of industrialization and in that respect she has made all possible arrangements to pool the mineral resources of her territory in the best possible manner. In order to get the best advantage of the different grades of minerals there has been an organization in U. S. A. styled "Bureau of Mines" through the activities of which the industrialists and the mine owners receive adequate help and proper guidance in the matter of maximum extraction, with safety and proper utilization of the minerals. A brief account of the U. S. Bureau of Mines is given in a separate article in this issue.

The Bureau of Mines should have as its main

objectives the promotion of safety in the mineral extraction, the conservation of mineral resources and the conducting of investigations on the mining, preparation and utilization of minerals. These ends are achieved through the development and introduction of safe practices and improvements in the methods of extraction and utilization of minerals of different grades and quality.

But the scheme proposed for the 'Bureau of Mines' in India would include for the present three technical branches, namely:—

(1) Mining Engineering;
(2) Mines Inspection;
and (3) Mineral Treatment.*

In the earlier stages it will function primarily in an advisory capacity without executive or statutory powers, nor will it undertake actual mining or any marketing of minerals. It will give advice on mining, marketing and will collect information and statistics, organize training and research, formulate policy and co-ordinate measures for the conservation and development of the country's mineral wealth.

It is not clearly understood what the Mining Engineering section actually signifies. If Mining Engineering section means devising improved methods of mining for maximum extraction of minerals with utmost safety then this section would really correspond to Mining Branch of the U. S. Bureau of Mines. The object of this section should be to point out to industrial public ways and means for maximum extraction of different minerals, as for example in the case of coal widespread sand stowing has been recommended. This problem of Indian coal mining has been a vexed one since its recommendation by R. J. Treharne Rees in 1919, by Foley Committee in 1920, Noyce Committee in 1925, Burrows Committee in 1937 and last by the Mahindra Committee in 1946. But even today we do not find any serious step to have been taken by the Government to pass the compulsory stowing into law. Without this there cannot be maximum extraction of coal and without this system coal properties cannot remain safe and secure to reach their maximum tenure of life. First stage of conservation can only be achieved by such process. The other aspect of conservation lies in the introduction of proper and specific uses of minerals for different uses. This subject of coal utilization has been grouped under "Fuel and Explosive Branch of the U. S. Bureau of Mines."

It is also not very clear what would be the functions of the Mines Inspection section of Indian Bureau of Mines. If it really means the information to be collected from the mines regarding the condition of mine atmosphere then this has already been the work of the Mines Inspectorate of the India Government as provided for by 'The Indian Mines Act, 1923'. A large amount of data are already lying in the files of the Chief Inspector of Mines. It is not known if the analytical data of mine gases, mine waters and other physical and chemical characters are maintained by that Department. This subject along with Safety and Health Division are included under "Health and Safety Branch" of the U. S. Bureau of Mines. It seems highly desirable that a separate branch called "Health and Safety" should be created for the good of the general class of mine labour and the Mines Inspection Branch should be amalgamated with it. It may be argued that the already existing "Mines Board of Health" of the different mining areas may be allowed to continue but a careful consideration would suggest that the health affairs should not be kept outside the Bureau but should find suitable and important place within the Bureau.

In order to have good and efficient work on a co-operative basis it is necessary that the different departments should be placed under one control and such a system will progress more smoothly when worked on a co-ordinated wheel. The proposed Bureau of Mines should have included sections *viz.* Coal Division, Coal Utilization Division, Synthetic Fuel Oil Division and Petroleum Division and we hope that this would immediately receive due consideration in view of the fact that coal mining and coal utilization seem to be the pivots round which almost every other industry revolves.

The newly started Fuel Research Station together with proposed regional stations are however expected to deal with these sections in detail and should form an important division of the proposed Bureau of Mines.

The mineral treatment section should direct in the matter of beneficiation methods both dry and wet suitable for the different grades of raw materials so that all types of ores might be better utilized for manufacturing finished goods.

A separate "Statistical Branch" should be created to collect, co-ordinate, publish and distribute all important information amongst the public and a suitable "Year Book" giving all statistical information in a systematic way and standardized form should be published regularly more or less in the line of U. S. Mineral Year-book. The quarterly journal "Indian Minerals" issued by the Mineral Information Bureau of the Geological Survey of India is a semi-scientific magazine containing certain articles on topics interesting to general readers. But inspite of such a magazine there should always be one standard yearly volume dealing with statistical information together with improved beneficiation, mining or metallurgical methods put under relevant mineral

*A sum of Rs. 3 lakhs is provided for in the first year to give effect to this scheme.

chapters. The scope and activities of this Mineral Information Bureau, we hope, will now be under the Bureau of Mines.

The administrative organization of the proposed Bureau, its head quarter and the details of its experimental laboratories have not been announced. But it would be reasonable to bring the work of the Fuel Research Institute, Dhanbad, directly under the control of the Bureau of Mines.

Similarly the National Metallurgical Laboratory should be brought under the Bureau of Mines. The Government is already spending large amount for the establishment of these laboratories and setting up of separate laboratories for the Bureau of Mines appears to us to be unnecessary.

It is also reasonable to suppose that the Bureau of Mines should be created at a place very close to the Geological Survey of India so that there may be close co-operation between the new department and the existing survey laboratory. It is needless to mention that the mineral affairs and the relevant scientific and statistical information being entirely in the files of the Geological Survey of India, the Bureau may be with great advantage be located in the same place as the Geological Survey of India.

The Bureau should have one Director and two Assistant Directors together with separate divisions with respective chiefs. The laboratories should be under the Curator who will be connected with the Director through their departmental chiefs. In brief, work on a close co-operative basis should be maintained to get the best advantage of the mineral resources by the combined brains and talents of the country through the planned organization of the Bureau.

It is hoped that the attention of the Central Government authorities will be drawn to these suggestions at the time of final drawing up of the detailed schemes of the proposed Bureau of Mines for India.

In order to give effect to the recommendation a sum of Rs. 3 lakhs sanctioned by the standing Finance Committee is rather meagre and very inadequate and we may request the Government to be more liberal in its grant in view of the fact that such useful and vital organization would materially contribute to India's economic progress.

It is absolutely necessary that schemes to set up a Bureau for efficient development of mineral resources for the industrialization of India should have been on a much bigger scale and in a more comprehensive manner, so that it would have been more effective and useful in various ways. However a good beginning should be made with additions of new departments in the immediate future with successful functioning of those with which the bureau starts.

THE U. S. BUREAU OF MINES

IN this article an attempt has been made to give a skeleton or a brief outline of the U. S. Bureau of Mines, an organization which plays so very important role in the industrial programme of that country.

It was on the 16th May, 1910, that the U. S. Bureau of Mines was established by an Act of Congress under the Department of Interior in order to promote safety in the mineral industries, to conserve mineral resources and to conduct investigations on the mining, preparation and use of minerals. In 1925, the Bureau was transferred to the Commerce Department but has again been under the Department of Interior since 1934. Since its inception, the Bureau has been doing useful work in diverse directions *e.g.* safety practices, improving techniques of mineral utilization and in publishing series of articles in the shape of cheap pamphlets dealing with scientific, technical and economic information for the benefit of those engaged in mineral industries.

According to the Act the chief objects with which the Bureau was started are as follows:—

> To conduct scientific and technologic investigations with regard to mining, processing and utilisation of minerals with a view to improvng health conditions, safety efficiency, and conserving mineral resources by preventing wastage in the mining, quarrying, metallurgical, and other mineral industries; to inquire into the economic conditions affecting these industries; to investigate into the explosives, mineral fuels, their efficient mining, preparation, treatment and use; and to disseminate information concerning these subjects amongst the public both technical and commercial.

The above Act also provides that the Director of the Bureau of Mines shall prepare and publish reports of inquiries and investigations concerning the nature, causes, and prevention of accidents, and the improvement of conditions, methods, and equipment with special reference to health, safety, and prevention of waste in the mining, quarrying, metallurgical and other mineral industries, and the use of explosives and electricity, safety methods and appliances,

and rescue and first aid work in said industries, the causes and prevention of mine fires etc.

According to the Act no member of the Bureau Staff should have any personal or private interest in any mine or to accept employment from any private party for services in the examination of any mine or private mineral property or to issue any report as to the valuation of such properties.

In the first three years of its life the Bureau gave attention chiefly to coal and coal mining by starting investigations into the causes and remedies for explosions in coal mines and by testing fuels of different places. In response to a general demand for giving attention to various mineral industries other than coal the Congress by an Act on 25-2-1913 designated the Bureau as "A Bureau of Mining, Metallurgy and Mineral Technology".

Further on 3rd March, 1915, by an Act the Bureau was authorized to establish and maintain several 'Mining Experimental Stations' and 'Mine Safety Station' in important mining regions to conduct investigations and disseminate information by publishing cheap pamphlets.

By virtue of an Act on 3-3-25 and 3-3-27 the Bureau of Mines became the sole agency entrusted with the production of helium for government use, including the acquisition of gas lands, drilling of wells, construction of plants and pipe lines and all other necessary operations. A further amendment of the above Act dated 1-9-1937 authorized the Bureau to place the surplus helium on the market for commercial sale.

It is quite apparent that U.S.A. Government as far back as 1927 thought it necessary to acquire the gas lands in order to have absolute control on helium. It is really unfortunate that Governments of India and Burma never took any initiative in similar line to have control on helium gas properties of Burma or of the metallurgical coal properties of Bengal and Bihar to safeguard the interest of their extremely limited reserves.

Other functions have been delegated to the Bureau from time to time by special legislation *e.g.* the War Explosives Acts of 6-10-1917 and of 26-12-41 authorize the Bureau to manufacture and sell explosives during the time of war. The Strategic Materials Act of 7-6-39 authorizes investigation of possible domestic sources of strategic minerals. The Act of 7-5-41 empowers the Bureau to enter and inspect coal mines for the purpose of obtaining the information necessary to improve the operation of mine with respect to the health and safety of the miners. Public Law dated 5-4-44 authorizes the Bureau to construct and operate plants to produce synthetic liquid fuels from coal, oil shale, agricultural and forestry products, and other substances.

In brief it may be said that the U.S. Bureau of Mines always considers as its major objective the promotion of safety in the mineral industries, the conservation of mineral resources and the conducting of investigations on the mining, preparation and utilization of minerals. In order to achieve these objects there have always been introduction of safe practices and improvements in the techniques of winning and utilizing minerals. Moreover, scientific, technical and economic studies in laboratory, office, and field have supplied useful information contributing towards the industrial progress of that country.

The organization of the Bureau of Mines has one Director and his office and two Assistant Directors one for programme development and the other for carrying out operations. The Bureau has six divisions for respective specialized activities namely (1) Fuels and Explosives Branch, (2) Health and Safety Branch, (3) Economics and Statistics Branch, (4) Mining Branch, (5) Metallurgical Branch, and (6) Administrative Branch. Every branch is in charge of one chief officer with assistants and is further subdivided into several divisions. According to the requirements each Division being in charge of one chief.

(1) *The Fuels and Explosives Branch* is split into five divisions namely (*i*) the Coal Division, (*ii*) the Division of Petroleum and Natural Gas, (*iii*) the Explosive Division, (*iv*) the Fuels Utilisation Division and (*v*) the office of Synthetic Liquid Fuels. The Branch is responsible for scientific research and technologic investigations pertaining to coal, petroleum, natural gas, and their products, and explosives, with particular reference to the conservation and most efficient utilization of mineral fuel resources.

(*i*) The *Coal Division* conducts scientific research and engineering investigations and tests on the chemical and physical properties of coal and on the mining, preparation, combustion, carbonisation, and gasification of coal. This work includes chemical and petrographic analysis of coals, investigation of coal deposits, studies of mining methods and costs, washing and preparation of coal for general and special purposes, research on the burning of coal in industrial and domestic furnaces, and research and tests on the making of coke, gas, tars, and byproducts. Most of this work is done at the Pittsburgh Experimental Station. Research laboratories and a pilot plant studying the drying and gasification of subbituminous coal and lignite are located at Golden, Colorado and Grand Forks, N. Dakota.

(*ii*) The *Petroleum and Natural Gas Division* conducts fundamental technical research and

field and pilot-plant tests relating to the production, storage, transportation and refining of petroleum, natural gas and their derivatives.

(*iii*) The *Explosive Division* conducts fundamental scientific research and tests on explosives and on development of new explosive mixtures, investigates causes of disastrous explosions in mines and devises methods of prevention of such explosions.

(*iv*) The *Fuels Utilisation Division* conducts technologic and engineering studies and tests relating to the inspection and utilisation of fuels and the operation and maintenance of fuel-burning equipment in the most efficient and economical manner. This division also provides information to government agencies, industry and the public on smoke abatement and the conservation and the efficient use of fuels.

(*v*) The *office of Synthetic Liquid Fuels* conducts research and development work on the production of mother fuels and other products from coal, lignite and oil shales.

(2) *The Health and Safety Branch* which consists of (*i*) Safety Division, (*ii*) Coal Mine Inspection Division, and (*iii*) Health Division, investigates conditions affecting the health and safety of workers in the mining, metallurgical, and allied industries.

(3) *Economics and Statistics Branch* studies economic problems of the mineral industry, prepares analytical reports thereon for public and government use, compiles and publishes statistics on sources, production, consumption, distribution, stocks, prices, employment, mine accidents, and other related factors in all branches of the mineral industries. These information are essential for the industrial planning and conducting Government operations. Further planning or improvement on the Bureau's programme will also depend on such statistics. Besides weekly and monthly reports this branch publishes an yearly volume entitled "Minerals Year Book" supplying many valuable information to the industry and the public. This branch consists of (*i*) Coal Economics Division, (*ii*) Non-metal Economics Division, (*iii*) Metal Economics Division, (*iv*) Accident Analysis Division, (*v*) Petroleum Economics Division, and (*vi*) Foreign Minerals Division.

(4) *Mining Branch* conducts engineering examination of mineral deposits that appear from preliminary evidence to warrant investigation from the national view point and studies possible improvements in mining and milling methods. This branch has ten regional or territorial divisions for working out the plants successfully.

(5) *Metallurgical Branch* develops (*a*) processes for ores that are not easily amenable to routine beneficiation methods, and (*b*) new techniques and special equipment and improvement which are introduced in the pilot plants. In addition to such research work this branch also conducts analysis and testing of ore samples from various experimental stations of the U.S.A. This branch has nine regional divisions for facilitating its programme of work.

(6) *The Administrative Branch is* responsible for the administrative management of the Bureau, including budget and fiscal management, distribution of publications, safe and healthful working conditions for employees, personnel management and the conduct of related administrative services including office inspection, surveys and organization, experimental stations and field offices.

This branch is in charge of one Chief Officer who is connected with his different divisions through their respective chiefs. The Chief of every branch maintains a small staff to assist in supervising the branch programme and in carrying out special responsibilities assigned to this office. The chiefs of all branches are connected with the Director and two Asst. Directors of the Bureau.

The Director of the U.S. Bureau of Mines runs the policy and official relations and controls over direction of various programme and activities.

The Assistant Director in charge of 'Operations' maintains coordination of activities within the Bureau and is busy in executing programme of work. The other Assistant Director of "Programme Development" also maintains coordination with the Department as well as with other Government agencies and also does the co-operative work with States and Industry.

In brief this is a planned organization with an efficient system of carrying out detailed programme of work of the different branches, divisions, sections and field offices etc. smoothly by maintaining connections, co-operation and co-ordination between the different units.

On the inception of a Bureau of Mines in India in the immediate future we would see the starting of a very useful organization and let us hope that it would be based on well thought out plan so that the mineral resources of this country may be fully utilized for the growth and development of various industries leading to economic progress of India.

The organizations of the office of the U.S. Bureau of Mines and of its Fuels and Explosives Branch, Coal Division, Fuels Utilisation Division, Petroleum and Natural Gas Division, and Synthetic Liquid Fuel Division are given in the Appendices A and B.

APPENDIX A

THE ORGANISATION OF THE OFFICE OF THE DIRECTOR, U. S. BUREAU OF MINES.

DIRECTOR.
Policy.
Public relations.
Official relations over all direction of programme and activities.

ASST. DIRECTOR (PROGRAMME DEVELOPMENT).
Coordinates with Departments.
Coordinates with other Government agencies.
Cooperative work with States and Industry.

Office of Minerals Reports.

ASST. DIRECTOR (OPERATIONS).
Coordination of activities within the Bureau.
Execution of programme.

Fuels and Explosives Branch | Health and Safety Branch. | Economics and Statistics Branch. | Mining Branch. | Metallurgical Branch. | Administrative Branch.

PHASES IN THE DEVELOPMENT OF HYDROELECTRIC PROJECTS

CHANDRASEKHAR GHOSH

DEPARTMENT OF APPLIED PHYSICS, CALCUTTA UNIVERSITY

As an integral part of the economic and industrial planning for India, general interest is now directed toward the development of all possible hydro power sources. Simultaneously with the problem of electric power development, projects for the control of rivers against flood and for navigation etc, are also being considered. As a result planning for multipurpose development of Indian rivers has assumed a very important place in the general future planning.

There have already been published in SCIENCE AND CULTURE several articles regarding different projects in and outside India, and the initial work that has to be done before actual planning and construction work can be started. In an article on "Multipurpose Development of Indian Rivers" (see SCIENCE AND CULTURE, July 1947) the stages in the multipurpose development have been discussed in brief.

In the light of information gathered and personal observations while with the Tennessee Valley Authority and with the Hydroelectric Power Commission of Ontario, some of the points discussed in the article noted above and some additional aspects in the development of multipurpose projects as also in hydroelectric projects in general, are now discussed in further details.

Water power development may be undertaken from two standpoints:

(1) In areas where natural fuel such as coal or oil is scarce or wanting but there is plenty of water power available, it is often considered advantageous to develop the water power resources to make the area independent of other countries or provinces for its power and industrial developments. The wide scale hydroelectric power developments instituted in the province of Ontario in Canada has been mainly from this standpoint.

(2) The multipurpose development takes into consideration not only the possibility of developing water-power, but also the question of prevention of floods, navigation, irrigation, prevention of soil erosion and other factors. The projects of the Bureau of Reclamation of the United States Government fall under this category. In this respect the developments by the Tennessee Valley Authority embraces all the different possible applications under the multipurpose development schemes.

For convenience the principal phases of a plan for unified development may be grouped under: (1) Preliminary Survey and Collection of Basic Data; (2) Engineering and Economic Planning; (3) Construction; (4) Operation and Utilization.

The different groups will now be considered separately in detail.

(1) *Survey and Basic Data.*—The importance of a well organized programme of survey and plan in the economic development of a hydroelectric project and the role of horizontal and topographic maps in locating dam sites and in estimating and planning land improvements, highways, and railroads have already been discussed in previous articles.

Where topographic contour maps are not available, preliminary information can be obtained economically and quickly by photographic aerial surveys. A ground survey party establishes over the area a number of base lines and elevations. From the photographs and with the assistance of surveyed lines and levels, drawings are prepared which enable the engineer to detect such features as the low spots of the flooded area or flowage plane. Very often they enable him to determine the elevation to which the water might be taken and the location of side dams which may be necessary to prevent "run-arounds."

Soil survey maps are useful in classifying lands in a program of erosion prevention.

An extensive programme of boring and drilling operations and geological explorations as aids to proper location of dam and reservoir sites, or waterways have already been discussed in earlier articles. These studies are of utmost importance to investigate the type and quality of the soil on which heavy structures may be founded in a stable and watertight manner. Power house foundations must be adequate, not only to withstand heavy loads, but the effect of vibration as well.

Geological studies are also made to ascertain whether valuable mineral deposits might be submerged in proposed reservoirs as well as to determine the major mineral deposits in the area, as their location and development may affect the use of navigation channels and of electric power and the planning of highway systems.

If it is proposed to construct earth dams of an appreciable height, it is necessary to take undisturbed samples of the foundation earth to determine its ability to resist the seepage of water and to support the structure. Such qualities as permeability, shear, density and grading of grain sizes are to be determined. Of particular importance is the selection of material for the 'core' or central water-tight portion of large earth dams.

Sand and gravel (or crushed rock) within convenient hauling distances are also explored, to determine the availability of a sufficient quantity for the concrete requirements of the project, and tests are applied to carefully selected samples.

Records of rainfall, evaporation, stream flow and the silt carried by streams are necessary not only to determine the feasibility of a project but also in forecasting floods during and after construction, in the operation of a unified system of river control, and in advising provinces, cities and industries on problems of flood control, stream pollution, and water supply. Flood forecasting is important also in relating flood control by the river under consideration to flood conditions in other river or rivers to which the river under consideration may be flowing into.

In case where flood records for the river under consideration are available for only a limited time, flood data relating to all river systems in that portion of the country as well as all the characteristics of the river system are essential.

To ensure maximum conservation of all the principal power resources on a river, careful consideration must be given to the possible effect of the development of any one site. By exploring the full storage and power potentialities of the watershed, an appropriate head and capacity for a specific site can be selected with the assurance that the most beneficial ultimate development of the river will be obtained.

In the survey of sites for dams and power stations, reference is first made to all available data. Suitable power sites within economic transmission distance are selected for further investigation by survey and preliminary engineering study, with a view to determining their relative merits. The engineer must consider the possibility of getting the maximum practical head at sites involving among other things, a study of all likely sites for dams, canals, headworks, tunnels, pipe lines and power house. Thus dams on the main river in a unified development should be constructed to the greatest height feasible under existing conditions.

In an unified development it is important to consider the simultaneous development of dams etc. on the main river and also its tributaries. Storage reservoirs on the main river and its tributaries are planned to accomplish flood control. The tributaries in the mountainous upper basins are the most important source of flood waters in most cases. The tributary reservoirs contribute materially to the effectiveness of the main river dams.

Another factor to be considered in preliminary investigations is the possible choice between a large number of low head dams and a smaller number of high head dams. Generally, low head dams, though serving the purpose of navigation, have no value for flood control purposes, besides the level of water is subject to great fluctuations thus introducing difficulties in the design of river terminals. A system of low dams might result in one of those inadequate developments that are later lost in the process of reconstruction on a more effective scale.

High dams on the other hand provide an effective measure of flood control and would be of such a character as to permit the conversion of water power into electric energy. The greater depth of water caused by high dams will result in additional lengths of navigation channels. One of the chief limitations upon a system of high dams is where the banks of the river are continuously occupied by principal railroad and highway systems.

The geographical and topographical conditions, the slope of the stream and the type of economic development of the valley must be considered in deciding whether these are favourable for high or low dams. Suitable foundation sites also influence the choice between the two.

Based on the information acquired through the several field and office investigations, comparative estimates are drawn up which include the more important features of each of the prospective developments, such as dams, canals, conduits, powerhouse with equipments, tailrace channel, transformation and transmission to the point of delivery, which may be an industrial area or a main trunk transmission line from which power is "tapped" at a number of points of demand.

In connection with the control of the Colorado river, the Bureau of Reclamation engineers considered the area tributary to the Colorado as composed of an upper and a lower basins, and examined a total of 70 possible reservoir sites in the two basins. The reservoir sites in the upper basin were found unsuitable on account of their smallness and as there were too many tributaries below them which might cause destructive floods.

The engineers favoured two good sites in the lower basin—the Boulder Canyon and the Black Canyon sites. After further intensified investigation, geologic and topographic surveys at these two sites, the Black Canyon site was finally decided on since there the depth of bedrock was less, the geologic structure was better and a dam of smaller dimensions would give the same reservoir capacity. The constructed dam, though called Boulder Dam—actually stands at the Black Canyon Site.

In the initial stages of the multipurpose project of the Tennessee river basin, the engineers considered a large number of possible dam sites and finally arrived at a stage where the choice lay between 32 low head dams and 7 high head dams. The final choice being in favour of seven high head dams, which together with the then existing Wilson and Hales Bar dams make in all 9 main river dams.

(2) *Planning*.—Having selected, after comparative studies, suitable sites for development, it is frequently necessary to obtain additional topographical and foundation data at the location of the principal structures, in order to determine their exact location and type. These data have to be obtained in sufficient detail to enable the office engineering staff to proceed with the design of the several parts of the project and to prepare the necessary construction drawing, to specify the capacity and type of the various items of equipment required and to arrange for its purchase and installation.

In the integrated control of the main river channel the question of location, size and building sequence for dams are of primary importance.

Thus private companies interested only in power generation will build dams only at good power sites, regardless of whether the location and the sequence of building are most favourable to navigation. But for the development of navigation it is important to plan the dams at proper intervals even though foundation conditions are less desirable and power possibilities less favourable.

A patchwork development might never result in a completely navigable channel. Similarly the requirements of flood control can be best realized in relation to an inclusive program.

These general requirements emphasize the importance of co-ordinated planning, both for navigation over long distances and for a combination of navigation, flood control and other interests.

Any individual development in a river system must be considered as a part of a whole development not only of the river under consideration, but also with reference to any other river or rivers to which it may be connected.

For instance, haphazard development of even the finest dam sites as isolated undertakings might prevent the best development of a unified system of dams. An individual or a corporation may pre-empt a choice site for a relatively small dam that thereafter may stand in the way of economical and effective general development. It may be found that a small site which stands out conspicuously in a local survey, would be entirely submerged in the backwater of a really important site that a general study would bring to light.

As an example of this, the case of the Wilson dam and the Hales Bar dam in the TVA system may be cited. These dams were constructed, before the organization of the TVA, as independent units for power generation only. The dams did not meet the requirements of units in a co-ordinated system under the unified development scheme and the heights of the dams had to be raised to fit in with the general scheme.

The necessity of simultaneous consideration of controlling the main river and its tributaries, in planning for a unified development, has already been mentioned.

In a program of unified development of a river system treatment of major tributaries is the concern of principal importance after, if not with, the development of high dams for navigation purposes.

It is worthwhile here to examine the construction program of TVA. In their first report to the Congress the Board of Directors of TVA recommended the construction of 3 major tributary dams together with the construction of 7 main river dams and reconstruction of the existing two main river dams. In actual construction program, the first dam to be constructed was the Norris dam on the main tributary Clinch river. The second tributary dam to be constructed was on Hiwassee river and this was completed almost simultaneously with the Chickamauga dam and before the construction of Watts Bar or Pickwick Landing dams on the main river. The third tributary dam, Fontana—the biggest in the TVA system—was started with the completion of Watts Bar dam and completed simultaneously with the Pickwick Landing dam.

There are always possibilities for power plants in the tributaries. Any such constructions should be co-ordinated with the unified development of the entire river system. Other benefits from the improvement of the main tributaries in addition to navigation, flood control and power are varied and important. In the control of tributary streams by reservoirs the low-water flow is increased by clear water from the reservoirs, which is of decided advantage in the prevention of stream pollution and for municipal and industrial water supply. Similarly, benefits result from the great reduction of silt-carrying water during floods. Among other benefits may be mentioned conservation and development of fish life, provision of recreation areas and game breeding by preserving the natural beauty of the lake formed by the reservoir and possibility of providing demonstration of forestry methods.

Similar considerations apply also to the smaller tributary rivers, branches, runs, creeks and intermittent streams. Reservoirs on the small tributaries are especially effective for local flood control and prevent bank erosion and consequent destruction of highways and other improvements along the streams and the washing away of soil with resultant silting below.

In planning for the generation and distribution of electric energy as a part of unified development, the improvements on the river system should be coordinated with undertakings in the adjoining regions, if there are any.

To a considerable degree, operation for flood control and navigation are consistent with the best operation for generation of power. For example, the release of flood waters during the period of low flow will increase the prime power capacity of the generating plants on the system, and this increase will be cumulative as the water flows through the successive plants below the point where the water stored in the reservoir is discharged into the main stream.

In this respect tributary projects operated in coordination with main river projects help to increase the so-called firm capacity, that is the capacity or power which is continuously available, of the unified development. In order to realize fully the highest continuous potential power, it will be necessary to interconnect the projects with adequate transmission facilities, so that generally speaking, the power market may be supplied from the main river plants in wet season and from tributary plants in dry season, and so that storage may be adjusted among the various plants in accord with rainfall or storage conditions.

In the initial stages of development, the actual installations of generating equipment should be limited to the needs of existing and prospective markets for power. Studies must also be made to determine the necessary provision at each project for possible future installation of generating facilities. The general principle is recognized that any plans made in the beginning should not foreclose developments, but it is not possible to indicate in precise detail what the sequence of development will be. In this connection the engineers of the planning section of the electrical engineering department play an important part in co-operation with the other departments. It devolves on them to prepare flexible long term plans for the overall development of the power system, into which the year-by-year requirements for new construction can be fitted in an orderly and economical manner. This point will be further discussed under the heading of operation.

In planning for the transmission lines in the system topographic map of the territory and profile map of the proposed route of the line are of great importance in the economic design of transmission towers and supports as also in the correct decision regarding the route to be adopted for the transmission line. Preliminary information about the ground resistance along the route and its vicinity is also of help in the choice of route and location of towers.

The importance of long term planning in an unified development cannot be too much emphasized. The development of co-ordinated plans both for works to be constructed at present and those that may be undertaken in the future, is a continuing process, and the skill with which it is done will largely determine the economy and quality of the resulting projects.

For flood control in an unified development, in addition to planning for control works on the main

river and tributaries, the problem of control of the smallest water course such as ravines, runs, gullies and creeks and of control of the erosion of the farm land in the watershed must also be considered. For maximum efficiency the ultimate development of the waterway presupposes such control.

In addition to construction of reservoirs on the larger streams with sufficient capacity to collect and store the silt washing off the farms and to store the flood waters from the denuded lands, it is well to supplement this with a program promoting types of farm and forest management that will greatly reduce erosion and consequent silting of streams, and that by forest cover, grass crops and farm terracing will hold more of the water on the land until it enters the soil reducing flood flow, adding to the ground-water supply and increasing the low-water flow of the river. This method does not involve the erection of any structures, but is a continuing process and a large part of the expenditure for flood control is by private investment but soil fertility will increase and more permanent agriculture will result.

Certain elements of social and economic planning are also necessary in preparing for dam construction. Studies should be made of the number of farm owners to be displaced by the reservoirs and of where they can best relocate. The condition of tenant farmers who must leave the reservoir is to be investigated and special effort ought to be made to help them relocate. Studies of land planning and land use, and of forests and forestry conditions in and about the reservoirs are to be included. Population studies should also be made for use in relocating highways, railroads and schools etc.

(3) *Construction.*—In the actual construction, the value of a unified program and of an orderly system of development is evident. Every effort should be made to arrange a sequence that will make possible the most economic construction. The major items of cost are construction equipment, operating equipment and skilled labour, besides materials of construction such as cement etc. By a well planned sequence of operation, construction equipment can be used to its fullest value. Similarly, the key men for specialized job can be passed from job to job and a high degree of skill and efficiency maintained.

In the design of dams and power houses and finally in the construction of the hydraulic can the electrical engineering departments must work together closely in order that all the equipments can be installed in a way which will assure the efficient operation of the plant.

The quality of work done in dam construction depends mainly on the quality of the concrete used and the nature of provision provided for allowing for proper volume changes during setting and due to temperature changes in the mass of the concrete. Hence there should be provision for testing each sample of concrete on site and also for sending samples to a central laboratory for studies of a more critical and detailed nature. Samples of concrete used in construction work have to be maintained for years to make observations as to changes that may be taking place in them with time. This central laboratory will also be responsible for making tests for the detection of cracks etc. in the concrete, for making observations of the actual progress in cooling in the mass of the concrete, as also for suggesting methods to be adopted for cooling.

In special cases, as in the case with Boulder Dam, it may be necessary to fabricate some of the steel structures on the site of the dam. In such cases, before the commencement of actual construction work suitable workshops and other installations have to be set up on site for the purpose of such work. These installations may be maintained even after the completion of the work of construction for maintenance and repair work.

(4) *Operation.*—With the completion of the several parts of a unified program, unified operation by a single regional agency is imperative, if the full benefits of the program are to be secured. Such an agency should receive and interpret rainfall records, river gaugings, and reservoir stages, and should dispatch water for flood control, navigation and power. In so far as the public interests require, it should decide where and when water should be stored and when it should be released through reservoir gates or by the generation of power. Only by a unified program of operation can the fullest use be made of the water resources of a river system.

The main purpose of *power system co-ordination* in an unified development is to predict as nearly as possible the available energy storage at the different hydro stations and to operate the stations so as to obtain the maximum possible output consistent with the program of navigation, flood control and malaria control.

As a guide to the amount of storage water and water elevation during the year consistent with navigation, flood control and malaria control, the practice, as followed in TVA, is to construct *basic rule curves* for the total system load—showing the energy in storage for the whole system against the time of the year. These curves are drawn with provision of reserves in case of drought and other calamities so that there will be sufficient water available even during dry years and the following year. These *basic rule curves* guide the total output of power for the whole system from month to month. In the light of experience

and data collected from year to year the basic rule curves are modified so that full advantage may be taken of the available water power after keeping the minimum amounts of energy in storage.

Besides the long time *prediction* in the operation of different reservoir capacities, there are also short time predictions for daily operating schedules of the different hydro plants. For this purpose short time predictions of power required to be generated are made on the basis of weather forecast data of rainfall and flow of water, of this power the power that can be generated by natural flow of water and extra power due to rainfall etc. are calculated. The balance of the predicted power requirement must be generated by draw-down water from reservoir dams. In drawing up the schedule of running of generators at the different power stations proper notice is taken of the fact that for any amount of water thus drawn from reservoir dams, the water flows downstream also in the downstream plants—allowing for the time interval necessary for the flow of water.

When the energy in storage is above the *basic rule curve* the ability to meet drought conditions may be taken largely for granted, and the primary consideration becomes the question of economy. When and in what amount the excess of available energy should be used either in place of auxiliary energy or for sale at a cheap rate? For this purpose a series of *auxiliary curves* can be drawn above the *basic rule curve* which would serve as a measure of the value of the increment of stored hydro-energy, and therefore as a guide to how much use of auxiliary energy can be made under various conditions in the zone above the basic rule curve in order to achieve maximum economy of operation. These curves are called *Economy rule curves.*

ROLE OF ELECTRICAL ENGINEERS

The electrical engineers in the planning section have a large responsibility in the successful operation and continuity of supply of the whole system. They are also responsible for planning ahead of any changes or addition in the system that have to be introduced—these changes may be the installation of new generators or substations, or relocating a sub-station or substations. They are responsible for planning the co-ordination of protective system for the whole project, for forecasting load growth and planning in advance any additional generation facilities to be installed.

For the purpose of successful planning, the planning section has at their disposal accurate and up-to-date information about the power system in the form of maps, diagrams, indices, tables and charts, showing the location and capacities of all generators, transformers and lines, not omitting the special limitations of any item.

Records of the size and location of the various power loads, their characteristic variations and the history of their growth made available by the section of statistics under the operating department, include the records of peak load both for the system as a whole and for the various geographic areas which form natural units from the point of view of power supply. These records therefore, govern the requirements for transmission lines.

PLANNING ENGINEER

The planning engineer is also interested in what is termed the reactive component of power. Suitable means to provide and transmit them is as necessary as those for generating and transmitting 'kilowatts' of power. If they are not adequately provided for there will be plenty of trouble chiefly by way of low voltage.

Another class of data required has to do with the continuity of service and the effect of such transients as flash-over on lines and equipments. It is desirable to keep a continuous record of the occurrence and location of such faults and the consequent behaviour of the system. From the automatic records and reports from the operators, a pool of data can be built up which is of great value to the planning engineer in specifying the characteristics of lines switching, generators and other equipments required to assure a continuity of power supply.

From time-to-time studies are made to determine the stability of operation of the system under various conditions of faults and load distribution. These studies are of great importance in determining and specifying the type of protective equipments and other electrical equipments that must be used for the stable operation of the system and for isolating the faulty part of the system. *Stability studies* also help to determine the nature of power generation with reference to load distribution that may be adopted for the system.

Based on a load estimate derived from yearly peak load charts over a number of years, long range studies are made from time to time by the planning engineers to form an appreciation of what the system should look like at least a number of years ahead. Such peak load charts, even with periods of "depression" and "boom" generally show a slope indicating that growth of load in maintained. An estimate extending the growth curve would be sufficiently close for preliminary studies in fitting in the

various power sites and indicating roughly when and where a new power development will be required.

ACCURACY OF SURVEY

However, before a new power development costing millions can be authorized much more accurate studies will be required. The first need will be an estimate of load growth with an attempt at a greater degree of accuracy for at least the period during which existing power sources are being exhausted and until the proposed new source will have been wholly consumed in load growth. As a matter of routine, estimates of load growth should be made year by year and a careful record kept to show the effect of various trends and factors on the growth. By careful analysis it is possible to detect changes in trend so that estimates can be made a year or more in advance.

The load estimates are discussed by the planning, operating and hydraulic engineers in consultation with the departments which are directly concerned with sale and load developments. The estimates of load are then compared month by month with existing resources, taking into account suitable reserves of generation which shall be available to take care of emergencies.

The results are incorporated in a chart which indicates the estimated peak surplus or deficit in the immediate future years under consideration. From a chart of this type it is possible to forecast the date for commencing the construction of a new development, taking into account the time required for construction. It may also provide a basis for decision whether the new development should be a "base load" plant wherein the generators installed is sufficient only to use the dependable flow of the stream or whether the site should be "over-developed" to carry peak loads by installing more generators. Additional units can be installed in many water power plant at low cost.

If there are several possible sites, one of which is to be selected for development, the procedure to be followed is to try to fit each of the alternative developments into the system by comparing its peak power and energy possibilities, as determined by the hydraulic department, with the load requirements of the system, and by determining what transmission lines and other facilities would be required to connect the new power plant into the system to assure satisfactory operating results.

In studying this latter aspect, it is advantageous to use the *"Network Calculator"*. By this method, the effect of alternative additions of generators and transmission lines can be tried out in a short time with the confidence that if the system is constructed with the characteristics used on the calculator the operating results will correspond. In such a study, a study of power flow indicates the area with the greatest deficiency of power to which the new power source should be most directly connected. By this means the necessary transmission lines to connect the new power site and to reinforce the system internally for the heavier loads are also indicated.

In this way, the alternative power sites are studied for widely differing conditions of load. Further studies indicate the value of short circuit current and the effect of these short circuits on the system. This information has a bearing on the transmission line requirements and the specification of the switching equipment.

Finally, a system is agreed upon, and specifications are prepared based on the results of the many sided studies. With these specifications the design section draws up estimates on cost of construction which will be consolidated with those of the hydraulic department for the respective sites.

The estimates provide data for a comparison of the respective schemes of development from an economic standpoint, and for a report on the capital cost, the cumulative cost, the transmission losses and the respective additions to the power resources of the system.

It will thus be seen that the use of Network Calculator is invaluable in the planning and operation of a large electrical system. In the United States and in Canada all large electric supply systems either possess their own Calculator or several utility concerns have combined to own a calculator on a co-operative basis.

In addition to what has already been mentioned, the scheme of development of a multipurpose project should include the provision of a central testing and research laboratory of its own. The testing section will be responsible for the testing of all construction and installations as also for all equipments in use in the project. The research section of the laboratory will be engaged in determining what improvements can be introduced in the system for better operation in power supply. The section will also carry on investigations on such matters as conductor joints and vibrations, remote control of loads, treatment of wooden transmission structure, paints and protective coatings, masonry materials, grounding and ground resistance, development and application of devices such as lightning surge detectors and recorders, fault localizers for transmission lines, strain gauges and crack detectors etc. Any large system will have problems peculiar to their own system and it will be the object of the research laboratory to deal with and solve such problems. In co-operation with other testing and research laboratories, they can also be of

help in the formulation of standards to be adopted in electrical power systems.*

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MAINTENANCE OF SOIL PRODUCTIVITY—THE KEY TO SOIL CONSERVATION IN INDIA

A. KUMAR DUTT,

NEW YORK STATE COLLEGE OF AGRICULTURE, CORNELL UNIVERSITY, ITHACA, NEW YORK

IN the last few decades soil erosion has been so conspicuous and mortal in its blow to the prosperity of agriculture and waterways in India that the necessity of its immediate solution has now become a problem of major national concern. Soil conservation is a colossal problem in our country ; so colossal in fact that it requires a critical review of our social and economic structures on the one hand, and of our farming and soil management practices on the other. Our soils have been farmed for centuries without having any appreciable fertilization except the sporadic application of manure which stands insignificant as compared to the annual withdrawal of nutrients by crops. Some are still producing a fair yield, especially the alluvial soils and soils under good management ; while others have deteriorated considerably in yield and food value of crops. Today, there are more marginal and submarginal lands than good arable lands in our country. The problem of soil conservation, which means to conserve the soil *in situ* and to maintain its productivity, is not as simple as some people may think.

"Because soil erosion was neglected for many years," says Kellog[1], "is not sufficient reason, of course, for exaggerating it now. In fact, it is serious enough as it is—exaggeration is unnecessary." Many wild guesses have often been made by some people to exaggerate the seriousness of erosion by assuming that it usually takes about 800 years to form one inch of soil, or that there is so-called equilibrium in nature between erosion and soil formation whereby the productivity of the soil is maintained. These sweeping statements are subject to serious criticism. The soil is not a static system as these people are apt to think ; but it is dynamic, being in a continual state of change under the forces of its environment. As will be shown later in this paper, one inch of soil may be formed in a couple of decades depending on the kind of parent material and pedogenic processes, and soils even under Nature's management may become unproductive in course of their genesis. However, from the stand-point of the life and dynamics of the soil, we may look upon erosion as a metabolic process of the soil body taken as a natural unit, the normal activity of which is to keep the soil young and fertile. In other words, too much erosion is serious as it removes the available products of weathering ; so is too little erosion, as in the humid regions, which impoverishes the soil through excessive leaching of nutrients in the drainage water.

Instead of making an arbitrary distinction between geological and soil-forming processes as some of the leading pedologists are apt to do, we should define with Jenny[2] the parent material as the initial state of a soil system, which gradually changes with time in its pursuit to come to a state of equilibrium. According to this concept, a mature soil is one that is in equilibrium with its environment. This is a much broader concept of soil formation and gives us a clear understanding of the processes whereby the minerals in the rocks are unlocked and redistributed under the influence of the environment.

Practically speaking, all soils, except of organic origin, are derived from solid or ground up rocks, which may have remained *in situ*, or which may have been transported elsewhere. The kind of rocks or their mode of origin is not of as much interest in pedology as it is in geology. Since, according to the climatic theory of soil formation, two different kinds of rocks under the same climatic condition will give

[1] Kellog, C. E. "The Soils that Support Us". New York, The Macmillan Co., 1941.

[2] Jenny, H. "Factors of Soil Formation", 1st ed. New York and London, McGraw-Hill Book Co., Inc., 1941.

rise to the same group of zonal soil, or the same kind of rock under different climatic conditions will produce different zonal soil groups Although, theoretically, the climatic theory is accepted by many pedologists, it might be well to point out some conditions where the climatic theory does not work. For example, the apparent lack of chernozems developed from acidic rocks such as granite, and the lack of so-called pedocals on rocks of acidic character in regions of low rainfall (<12 inches). However, to the students of soil fertility and agronomy the composition of the rocks and their relative abundance are of considerable importance, *e.g.*, the slates and the quartzites are very resistant to weathering and give rise to poor soils, basic rocks produce more fertile soils than acidic rocks under the same climate, and so on.

The soil-forming minerals are formed by the chemical combination of the elements which differ widely as regards their relative abundance in the lithosphere. For example, oxygen is the most abundant element present to the extent of 49·3 per cent, followed in decreasing order by Si, Al, Fe, Ca, Na, K, Mg, P, S, etc. Rocks, on the other hand, are composed of minerals, seldom of only one, but almost always of many kinds of minerals. Feldspars are by far the most abundant of all the minerals and constitute about 59·5 per cent of the material contained in igneous rocks. Next to feldspars stand amphiboles and pyroxenes present to the extent of 16·8 per cent of the entire lithosphere, followed by quartz (12·0 per cent), micas (3·8 per cent), apatites (0·6 per cent), and the less abundant rock-forming minerals (7·3 per cent). Apatites are also found in small quantities in sedimentary and metamorphic rocks, and they are more common in femic than in the more silicious varieties of the igneous rocks. The geologists estimate broadly that the lithosphere contains on the average 95 per cent of igneous rocks and 5 per cent of sedimentary rocks consisting of sandstone, shale, and limestone.

Soil may be defined as a product synthesized under natural conditions by the interaction of different physical, chemical, and biological forces operating on the parent material, having poorly or well developed genetically related horizons depending on the intensity and duration of these forces, etc. Weathering by physical forces, such as unequal heating and cooling of the different minerals in the rock body, or alternate freezing and thawing, causes disintegration of the rock with an increase in specific surface favouring more rapid chemical reaction. Chemical weathering is essentially a hydrolytic decomposition of the mineral silicates accompanied by the liberation of the hydroxides of the alkali and alkaline-earth metals, as well as with the formation of complex alumino- or ferro-silicic acids. These bases are partly adsorbed by the complex silicates containing Al or Fe, and in some cases Mg and Mn, which constitute the clay minerals ; and are either partly leached out in the drainage water as in the humid regions or partly present in the soil as soluble salts as in the arid regions. In regions perpetually covered with snow, weathering is mainly physical because of temperature being a limiting factor, so it is in extremely arid regions because of moisture being a limiting factor. But the rate and period of chemical weathering increase progressively in passing from the temperate towards the tropics, becoming most active in the latter. According to Ramann, weathering in the tropical regions is three times faster than in the temperate zones, and nine times more rapid than in the arctic. As regards the depth of weathering, the depth of the soil may be a few inches or a few feet in the temperate regions ; but it attains a huge thickness in tropics and sub-tropics. Often one may have to dig 130-160 feet before the fresh rock is exposed, and a depth of 1312 feet has been reported by Vageler.

There has been much speculation about the rate of soil formation. Although no detailed and systematic study has been made in this direction, few field and laboratory observations are available which may be taken with reserve. Jenny[2] presents a review of the literature dealing with soil formation as a function of time. It may not be out of place to mention here some of these interesting observations. For example, Akimitzev's observation on the decay of the Kamentz fortress in Ukraine, U.S.S.R., shows an average thickness of twelve inches of soil having been formed from limestone in 2330 years. On October 31, 1928, Ecoma Verestege made some observations on Langeiland island (between Java and Sumatra), which had received a deposit of pumice as a result of the stupendous volcanic eruption of Krakato in the Sunda Strait on August 26 and 27, 1883. He found that in 45 years the surface soil had attained a thickness of 13·8 inches and there was remarkable removal of Na and K for this brief period. Hardy's works with the recent volcanic ash soils of the Soufriers district in St. Vincent, British West Indies, show that within ten to twenty years sterile volcanic ash may give rise to fertile soils under the prevailing circumstances, with a considerable accumulation of organic matter and nitrogen. These observations cause one to question the general validity of the statement that one inch of soil is formed in about 800 years.

With the progress of weathering, vegetation comes into play and a new condition of equilibrium is set up. At first plants with minimum requirement for nutrients get their foothold in the partially weathered material, and a competition for existence gradually ensues between plants with different requirements. Some die out, while others survive in

their struggle, and finally a "climax vegetation" becomes dominant. With vegetation new conditions of equilibrium arise, and regional soil development processes begin. There is now a redistribution of moisture between the plant and the soil system. Moisture loss as vapour is enhanced since there is more loss of water from flora-clad land than from bare soil. A portion of the precipitation is retained by the soil colloids and thus participates in weathering, while another portion, especially in the humid regions, removes the soluble products of weathering and hastens the process. But this is not all. The vegetation and the climate now begin to exert their combined influence on soil development processes. Erosion is retarded by the canopy of the vegetation and the binding effects of the roots. Surface run off is reduced depending on the nature and density of the vegetation, and downward percolation of rain water is accelerated.

It may be interesting to quote here the opinion of some of the authorities on soil development under natural conditions in tropical and temperate regions. In spite of the attention given to explain the origin of laterite soils, there is still much confusion as to the real nature of soil formation and development in the tropics. Mohr's[3] works on tropical soils and his suggestions about the selection of the right type of agricultural enterprises in such soils have at last been brought within the grasp of our knowledge through an English translation by Pendleton. In the opinion of Mohr, due to intensive leaching even under virgin conditions there comes a stage when the weatherable minerals themselves are exhausted and the adsorbed bases plus SO_4, etc., are also practically leached out. Then the vegetation moves in the cycle: Organic matter→mineralized→into the roots→ into the plant above ground→plant residues→ organic matter, and so on. But with each cycle losses occur, vegetation becomes sparse and finally dies out. If there were no erosion, presumably weathering would proceed in this way. However, the senile stage may be reached even in the presence of erosion in the course of centuries, when vegetation becomes thinner and erosion increases to remove what is still left of the elevated horizon. In this way the iron layer finally becomes exposed, dehydrated, and aged, and then forms the surface crust. Underneath lies the alumina layer, chiefly as nodules, and immediately below it is the more or less silicified tuff lying upon the parent material. That is the laterite stage!

De Turk[4] in discussing soil conservation from the viewpoint of soil chemistry gives a dynamic interpretation of soil development in the humid temperate regions. He states: "Soil deterioration is brought on by the natural processes of soil development, which may be modified in kind, or more frequently, in relative rate of progress, by agricultural practices when land is brought under cultivation. . . . The development of a soil, as Marbut has emphasized, is a constructive process. But the continued action of the same forces, where no accretion occurs by alluvial deposition or by lowering the profile through natural erosion, is capable of reducing a soil to a very low level of producing capacity, particularly under conditions of poor drainage. . . . All of these observations fit together to indicate that nature undisturbed in the climatic region under consideration will eventually wear out a soil with respect to its P as well as in other respects."

The effects of excessive water erosion are evident in the hilly sections of our country by the presence of truncated profiles or gullies. Whereas, the chemical sterility of the low-level laterites to a considerable depth may be attributed partly to greater downward leaching than surface run off and erosion. Kellog[1] states, "Some nearly level silty soils are poor for crops because of little run off while they were being formed. A large part of the so-called 'worn out' soils of eastern United States are of this kind—they never were fertile for crop plants, not even 'when the Indians had them.'"

The situation is different in the arid regions. Because of the accumulation of soluble salts near or on the surface, a scanty shrub type of vegetation is prevalent there. The soils of the arid region, when irrigated with water and properly drained, are usually very productive, since they contain sufficient amounts of available phosphate, potash, and other nutrients. Although the content of organic matter and nitrogen is usually low, most of the N is present in the easily available form. Depending on the severity of the climate, both water and wind erosion may play their role. Wind whips up the finer insoluble products of weathering and also partly the surface crust of soluble salts. Equilibrium is thus disturbed and fresh surface is exposed to weathering agencies. In the transition zone between arid and humid regions, weathering processes are of intermediate nature, and the grass type of vegetation is dominant, as in the black-cotton soils of India. Such soils are usually very productive, and there is little loss of nutrients by leaching.

Today, about three-fourths of the earth's surface is covered by sedimentary rocks or by material of detrital and alluvial origin. The formation of a fertile soil rich in N and organic matter may require under certain conditions hundreds of years. Every

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[3] Mohr, E. C. Jul. "The Soils of Equatorial Regions with Special Reference to the Netherlands East Indies". Translated by R. L. Pendleton. Ann Arbor, Michigan, J. W. Edwards, 1944.

[4] De Turk, E. E. "Soil Conservation from the Viewpoint of Soil Chemistry". *Jr. Amer. Soc. Agron.*, 29, 93-112, 1937.

year the grasses and forests add some organic matter to the soil by root decay or leaf-fall and so on. A portion decomposes and escapes as CO_2 gas, while the rest accumulates as humus and other intermediate decomposition products. This process is carried out mainly by soil micro-organisms, and finally an equilibrium is reached between the amount added and that decomposed. Fungi usually become predominant in the surface litter of the forest soils; bacteria, on the other hand, are the dominating species in grassland. Although the decomposition of organic matter is most rapid in the tropics, the annual production under virgin condition is, nevertheless, very striking. An annual production of above-ground organic matter from eleven to twenty-two tons per acre has been observed by different investigators, and even forty-five to ninety tons in the tropical rain forest have been recorded by Vageler. While an annual production per acre of 1·4 to 2·8 tons for the temperate forests, of 0·22 to 0·44 tons for alpine meadows, and of 0·71 to 2·22 tons for prairie grasses have been reported by the European and American investigators. Also, no less important is the addition of organic matter from under-ground growth, namely roots. In case of some grasses it may even equal or exceed the total aerial growth.[3]

Today, our virgin forests and grasses have almost completely disappeared and with them their dense canopy and their protective influences on the soil. Since the lands were brought under the plough, the organic matter was incorporated with the soil and began to disappear rapidly through microbial activity accelerated by tillage operation. The previous root channels promoting good physical condition of the soil on decay were being gradually filled up by the washing in of the soil particles from above. In many cases perennial crops were replaced by the annuals, and mixed crops, so characteristic in nature, were substituted by "monoculture". The addition of organic matter from the residues of cultivated crops was fairly low. The accumulated natural "reserve" declined rapidly at first, then the absolute loss was proportionately less and its decline less noticeable, until the soil was brought to a state of low organic matter content in equilibrium with its new environment. Experiments in Ohio and Missouri Experiment Stations point out that intertilled crops such as corn, potatoes, cotton, etc., are twice as destructive as small grains like oats, wheat, and barley, in exhausting the organic matter "reserve" of the soil. As a result of the disappearance of the organic matter, soil structure deteriorated and the porosity, especially the non-capillary pores—so essential to free drainage and good aeration, was reduced. Consequently, the soil became more compact and less receptive to rain water and proper root development was hampered. In other words, this is the man-induced physical change in the soil that accelerates run off and erosion, increases flood-hazard, and accentuates occurrence of drought injurious to the growing crops, etc.

Now, we shall consider the deterioration of our soils from the view-point of soil chemistry, as influencing, or influenced by, soil erosion. When the virgin forests and grasslands were first used for agricultural purposes, the crops used the accumulated "reserve" of fertility which was usually greatest in the surface soil. The yields might have possibly remained fairly constant in the beginning and then began to decline as the "reserve" was being gradually exhausted. Losses of nutrients occurred through harvested crops, grazing, erosion, and leaching in the humid regions; while the gain was especially through manure, sowing seeds, and occasional growing of legumes. Due to their economic distress our farmers most often use the cow droppings as fuel. However, the amount they return to the soil per acre is less than a ton on the average, which is quite insignificant to replace the total loss. Moreover, manure is an unbalanced plant-food carrier. The practice of growing and ploughing under legumes in a rotation, so essential and economic to restore the organic matter and nitrogen content of the soil, had to be gradually abandoned due to the more pressing needs for growing crops for human consumption. It should be pointed out, however, that merely growing a legume does not necessarily enrich the soil in N if the crops are harvested. It has been observed by some workers that of the total N used by legumes, two-thirds is supposed to have been contributed by symbiotic bacteria and is removed in harvested crops; approximately one-third of the total amount is taken up from the soil "reserve" and remains in the roots and stubble.

It is necessary to discuss briefly the nature and magnitude of the nutrients lost through erosion. Generally the surface soil of cultivated lands is richer than the sub-soil, in P and organic matter, which contains almost all the N and S in organic combination gradually decomposing into simple inorganic combinations through bacterial action. Although the surface soil contains less total K than the sub-soil does, the availability is greater in the former. The greatest loss due to erosion of cultivated lands is the loss of organic matter from the surface-foot of the soil, as well as the loss of fine silt and soil colloid The non-colloid fraction usually consists of primary minerals and, being resistant to weathering, changes slowly. They are, therefore, of least significance as an immediate source of nutrients for crop growth, though not necessarily in the humid tropics, in the temperate and other regions. Micas occur chiefly in fine silt and coarse colloid and it is the loss of these fractions which accounts for K deficiencies in soils.

Similarly, phosphatic minerals, both primary and secondary, are resistant to weathering and thus of low degree of availability to plants, and the loss of the colloid fraction of the soil means a loss of available P.

The loss of nutrients in the drainage water in humid regions also requires very serious consideration. Experiments to determine this loss have been conducted at the Agricultural Experiment Station at Cornell, Genevea, and Tennessee in the U. S. A., and at Rothamstead and Aberdeen in Great Britain, and elsewhere. It is not possible to go here in detail about these experiments. The readers may consult the book of Lyon and Buckman[5] for references. Apart from the conflict in the observations of the different workers, certain features are particularly outstanding. There is very high loss of N from bare plots, very small amount from cropped fields, and negligible amount from sod crops. Due to the small amount of P in the soil and the tenacity with which it is held by the soil colloids, its loss in drainage is very negligible. With soils of medium to heavy textures, losses of N and P as removed by crops are greater than those removed by leaching. The seriousness of leaching is reflected in a practical way by the high losses of Ca, Mg, and to some extent by that of S. The position of K is intermediate. The high loss of Ca even under cropping conditions suggests that this element is particularly very mobile and subject to loss by leaching. Lyon and Buckman (*loc. cit.*) in summing up the effect of leaching on soil fertility remark: "Were it not for leaching, we would have no lime, sulphur, and potash problems or they would sink into insignificance. The idea that crops in themselves and alone are responsible for fertility decline is absurd. Leaching and erosion play their part, and it is a large one, in reducing the productivity of soils."

The above trend of drainage losses is substantiated to some extent by a study of the analytical results of river and sea water. Clarke[6] has given a review of some of these studies. For example, Na and K are nearly equal in amounts in the igneous rocks, but they pass unequally into the streams in the proportion of 4 : 1 respectively. In the ocean the difference is further increased, Na being thirty times the amount of K. In general it may be said that, with a few exceptions, the analyses of the river waters show the common nutrient kations in the following order: Ca>Mg>Na; but there is a complete reversal of the order in the oceans. The relative proportion of the anions CO_3, SO_4, and Cl are in the decreasing order as named, while the order is reversed in the oceans. There is little or no trace of P in either the river or the ocean, and the proportion of K is quite small as compared to other kations.

Almost all over India our soils have declined in fertility, incapable of maintaining the health of our population with the requisite supply of a well-balanced and normal diet. The chemical depletion of our soils has advanced so far that their long-time cry for the return of nutrients is now becoming more obvious by the prevalence of diseases like ricket, ostomalacia, tooth-decay, etc., among our population. Furthermore, our cattle are not free from diseases resulting from malnutrition. As may be seen from the works of Harrassowitz and Fox in India, Lacroix and Boiteau in Guinea, the laterite soils are very poor in essential nutrients. The alkali and alkaline-earth metals are either present in very small quantities or entirely lacking down to a considerable depth in the soil. Na is almost entirely leached out, while K may be present in certain cases in very small amounts but very slowly available to plants. In almost all the cultivated lands in India N and P are invariably deficient, whereas K will usually be deficient in sandy and organic soils, as well as in the highly leached soils of the humid sections of our country.

The measures to be advocated for controlling erosion in India should be simple and inexpensive. In fact, the problem of soil conservation will vary in different sections of the country, yet the general principles may be briefly stated here.

The first step in the control of run off and erosion in the cultivated lands should be to establish a vigorous plant cover. This will require adequate soil fertility and soil tilth. A vigorous plant cover will protect the soil from the beating and eroding action of the rain water, and will also leave more organic residues in the soil. Instead of growing continuously intertilled crops, a sound rotation within the economic reach of the farmer must be adopted. Grass, preferably a mixture of grass and legume, should be included in rotation. The beneficial effect of grass in improving soil structure has long been recognized. Bradfield[7] states: "There is little evidence to indicate, however, that a good physical condition of the soil can be maintained when planted continuously year after year to intertilled crops even when generously fertilized. The yields of wheat on the Rothamsted Experimental Station have declined and the physical structure deteriorated even when twenty-five tons of manure per acre per year were applied."

The benefit of practising a definite rotation from

[5] Lyon, T. L., and Buckman, H. O. "The Nature and Properties of Soils". New York. The Macmillan Co., 1943.
[6] Clarke, F. W. "The Data of Geochemistry, 4th ed., Washington, Govt. Printing Office, 1920.

[7] Bradfield, R. "Soil Conservation from the Viewpoint of Soil Physics". *Jr. Amer. Soc. Agron.* *29*, 84-92, 1937.

the standpoint of soil conservation can be seen from the following table which is self-explanatory:

Crop Treatment*	Run Off	Soil Loss in Tons per Acre	Cultural and Cropping System†	Run Off	Soil Loss in Tons per Acre
Cotton Continuous	15·33	25·47	Fallow, ploughed 8 inches	30·3	41·0
Cotton‡ ..	13·83	15·37	Continuous Corn	29·4	19·7
Wheat‡ ..	14·52	1·72	Continuous Wheat	23·3	10·1
Sweet Clover‡ .	8·31	0·62	Corn, wheat, Clover	13·8	2·8
Average for Rotation .	12·22	5·90	Continuous Bluegrass	12·0	0·3

The adoption of other simple erosion-control measures such as contour farming and strip cropping will also be economically feasible and will help to check erosion in our cultivated lands. Here also rotation will be a usual practice. Evidences from different experiment stations in the U. S. A. indicate that contour farming with well-established sod-waterways used in combination with recommended soil treatments and crop rotations may reduce erosion from 50 to 100 per cent. Strip cropping is more effective than contour farming alone, in checking erosion. It can be recommended for slopes too erosive for contour farming, because the entire slope is not ploughed for any one erosive crop, and no two adjacent strips are ploughed at the same time. In addition the entire soil is not deprived of protection against erosion. These two measures may also be recommended for regions subject to wind erosion.

The control of wind erosion will also consist in applying simple and inexpensive measures, such as trashy cultivation, wind-breaks of living plants or picket fence, rough soil surface, blanket of vegetation, as well as holding water by level terraces, contour furrows, or lister furrows, and so on. Experiments in this country have shown that leaving plant residues on the surface, unlike the practice of ploughing under, decreases the blowing and washing of the soil. But this practice interferes with weed control in the humid sections of the country. In controlling gullies advantage should always be taken first of healing with the help of growing vegetation adapted to the particular environment, or of such simple structures as bush or earth dams, in order to allow the vegetation to make a stand.

* Red Plains Soil Erosion Experiment Station, Guthrie, Oklahoma, U.S.D.A., SCS-AP-6, P. 4, 1936.

† Fourteen years' results. *Missouri Agricultural Experiment Station Research Bulletin 177*, 22, 1932.

‡ A 3-year rotation.

Terracing is a very costly operation and the feasibility of its practice under general farming in India is very much doubted. The maintenance of a stable terrace channel with a safe outlet is the prerequisite to successful terracing. Terraces are very helpful on gentle slopes, particularly where there has been but little erosion. But for the steeper slopes of the same kind of soil, terraces are not as useful for the growing of cultivated crops as they are when used as an adjunct to permanent pasture. Moreover, the construction of broad-base terraces on soils having a dense and impervious sub-soil may require a part of the unproductive sub-soil to make a new surface soil. However, level, or nearly level, terraces may be used on permeable and gentle sloping lands in regions of low rainfall where water control is the primary objective. It should be pointed out that terraces alone cannot provide complete protection against erosion unless reinforced by rotation of crops, contour farming, strip cropping, and so on.

Many of our present marginal and sub-marginal lands, badly damaged by erosion, may need to be put under grass or forest for restoration of their productivity. Grass sod, if properly fertilized, is very efficient in increasing the productivity of the worn-out soils. In an experiment started in 1897 in Northhumberland, England, and still in progress, it has been shown that a field fertilized with basic slag equivalent to about 1000 pounds of 20 per cent superphosphate per acre at intervals of six years has steadily built up the top-soil at the rate of approximately half an inch per annum and is thickly interspersed with the fibrous roots of grasses and legumes (fig. 1*a*). The adjacent untreated plot possesses little

Fig. 1*a*. Fertilized grassland with a well-developed dark-brown A horizon.

more than an inch of true top-soil, overlying a stiff, yellow-coloured clay, with few roots (fig. 1*b*). In addition to being used as pastures for cattle, such grasslands have immense potentialities to supply human food in case of any national emergency. For example, more than four million acres of England's famed grasslands were ploughed up during this war,

with remarkably high yields of grains, potatoes, and other crops.

Fig. 1b. Unfertilized plot with little A horizon. (By courtesy of Assistant Professor D. B. Johnstone-Wallace, Cornell University.)

The regeneration of our eroded soils by putting under grass or forest will require additional lands to be brought under cultivation or additional means to increase the yields, or both. This may be successfully done by: (1) bringing arable waste lands under cultivation with good drainage, irrigation, and so on: (2) by forcing up the productivity of our present cultivated soils by liberal fertilization and liming, good soil management, and good farming practices, etc.; (3) adopting suitable and inexpensive erosion-control measures: and (4) using high-yielding strains of crops, etc. It should be noted here that the use of high-yielding strains will deplete the soil fertility more rapidly than the ordinary varieties and the yield will then go down unless liberal application of fertilizers or manures is occasionally made.

Closely connected with our national soil conservation program is that of ameliorating "*usar*" lands, which cover vast tracts of our country. The injurious concentration of soluble salts in the root zone, or in some cases the predominance of Na ion in the clay complex, has rendered these soils unsuitable for agricultural use. However, by leaching with underdrainage and by treatment with gypsum, and so on, such soils can be utilized quite economically. The intensity of reclamation will depend on the nature and properties of the soil to be dealt with. As already mentioned, they usually contain sufficient K, P, etc., for growing luxuriant crops for a number of years. The use of alkali-resistant crops such as sugarbeets, sorghums, barley, alfalfa, etc., is an important feature in the utilization of alkali lands. Some fruits like pears, oranges, and especially grapes are markedly alkali-tolerant. Unfortunately, this problem in India has not yet received the attention it deserves. Here also the occasional growing of legume and grass sods will improve the soil structure so often affected by the formation of a thin surface crust by irrigation water. In Argentina experiments are in progress to reclaim her alkaline and saline soil for agricultural purposes. After one or two years of irrigation barley and sorghums are grown in alkali and saline soils respectively, which are later ploughed under as green manures and followed by alfalfa or

Fig. 2a. Land before reclamation.

cotton. No manures and fertilizers have been used in these experiments, which were started in 1941. An average yield of 720-1300 lbs. pounds of seed cotton to the acre as compared to 172 pounds in control was obtained. The reclaimed land with a stand of sorghums which attained a height of about 71 inches in full growth, is shown in fig. 2b in contrast to the barren land before reclamation.

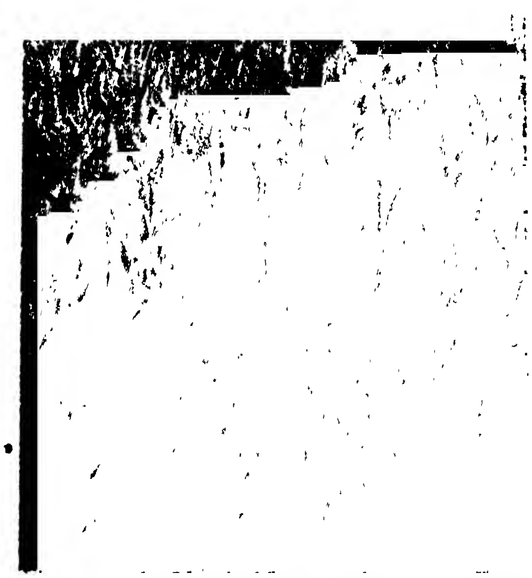

Fig. 2b. Land after reclamation and planted to sorghum. (By courtesy of Mr. Manfredo Reichart, Facultad de Agronomia Veterinaria, Buenos Aires.)

Pasture management deserves some special attention in connection with soil conservation. Today, there is a serious shortage of pasture lands in our country. From the experiences of other countries it can be said with a fair degree of certainty that occasional application of superphosphates, lime, and potash in some cases, will be most indispensable in maintaining the quality and quantity of the forage crops, although the N requirement may be met to a considerable extent by growing legumes in combination with grasses. We should not exaggerate the degree of effectiveness of controlled and rotational grazing in checking erosion under conditions where no provision is made for applying the nutrients to the soil to compensate for those partly fixed by the cattle and partly sold off the farms as dairy products. No campaign for fewer and better cattle or for rotational and controlled grazing can succeed unless there are plenty of thrifty pastures in our country. Similarly, a gradual replacement of our plough and transport cattle by tractors and modern vehicles is as vital to our national economy as is a campaign for fewer and better cattle. This will remove the unnecessary pressure on our lands and increase the efficiency of the marketing for agricultural products, and so on. This will decidedly favour the practice of better soil conservation.

A few words about flood control. It must be remembered that successful flood control should require good soil conservation: that is, the utilization of the entire water-shed of the unruly river should be planned on the basis of slope class. Strongly sloping lands should be put under forests, better on the community basis so that each village or a group of villages will own a certain area of forests to be managed by proper silvicultural practices. This measure will enable them to release cowdung for manuring their crops. Moreover, afforestation will have additional advantages in our national economy which cannot be discussed here in this short article. Lands in next grade of steepness should be put under pastures, while moderately sloping lands may be put under the plough with proper erosion-control measures already discussed.

I have discussed at some length the physical side of the soil conservation problem in the light of the feasibility of the application to our country of the various mechanical and biological control measures which have been developed in U.S.A. as a result of experimentation. By constructing a few terraces or by asking our farmers to adopt such and such erosion-control measures would not solve the problem unless a vigorous and thrifty growth of vegetation can be maintained, and this can only be done by keeping the soil in good tilth and fertility. Chemical fertilizers, like good soil management and farming practices, will play a great role in making soil conservation a success. Additional expenses incurred in adopting erosion-control measures should be compensated by increased yields partly through fertilizers. Fallowness which impoverishes the soils through leaching and erosion should be abandoned.

It would be erroneous to decide if erosion is the cause, or effect, of declining soil productivity in our country. There is no use in arguing as the scientists of the nineteenth century did about the cause and effect of material phenomena, but we have to understand the true nature and role of the different processes that are at work to bring the rocks and minerals in equilibrium with the environment, marking off the different states of the equilibrium by a series of changes in their flora and fauna either in amount or in kind. We should look upon cropping as a means to accelerate some of the processes which have been going on at a slower rate under natural conditions, and that the removal of the chemical elements in crops harvested from the lands adds to the depletion of the more easily available portion of those elements. We should also see that normal erosion is not interfered with in our soil conservation program, that leaching is not accelerated at the cost of erosion, and that our more productive soils are not neglected while putting too much emphasis on the "problem boy." Bradfield (*loc. cit.*), in discussing soil conservation from the viewpoint of soil physics, states: "In our national soil conservation program we must not allow our more productive arable lands to become the neglected step-child in our pedological family."

The success of our national soil conservation program will also need a change in our present land-tenure system. The economic instability of our farmers has forced them to forsake the practice of good soil management inherited from our ancestors. Can we expect a farmer to care for keeping up the productivity of a land on which he owns the right to plough for one year and is deprived of the same right the next year? Or, can a farmer having ownership over a small plot of land be expected to adopt a sound rotation of crops when he has to devote almost his entire land to growing cash crops intensively for his living? We cannot help our people by simply imbibing ideas from America and England unless we can translate them into action. These are the problems we have to tackle and solve.*

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SOAPLESS SOAPS

SANTI R PALIT

PHYSICAL CHEMISTRY DEPARTMENT, INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE, CALCUTTA

To the layman 'soap' is associated with detergency (cleansing), foaminess, slipperiness, wetting action, emulsifying power and many other well-known typical properties. To the chemist 'soap' stands for some sodium or potassium salts of fatty acids obtained by saponifying fats and oils with caustic alkalis. The term 'soapless soap' is used to mean substances which have quite a few of these typical properties of soap but are chemically quite different from the ordinary soaps. In fact they are often derived from sources other than fats and oils of vegetable and animal origin, which latter serve as the chief sources of raw materials for common soaps. In some cases, they are derived directly or indirectly from petroleum but quite a few of them are derived from fats and oils through a series of chemical reactions.

Limitation of Ordinary Soaps

The common soaps suffer from a great drawback; they cannot be used efficiently in hard water, which not only causes wastage of the soap by precipitating it as calcium and magnesium soaps but also produces an unsightly soil on the cleansed material by depositing this sticky precipitate on it. Also, in the textile industry very often special types of detergents are required to be used in an acid solution say, in a scouring bath, and in many processes good wetting agents or surface tension depressants similar to or better than ordinary soaps but having none of its usual disadvantages are wanted. Attempts were therefore made to produce some substances which maintain their soapy properties under these stringent conditions where ordinary soaps failed to do their duty.

Historical Development

Dyeing assistants, such as Turkey red oil (sulphonated castor oil) which in some sense is a soapless soap are known and have been used by the textile industry for a long time. But the real start in the industrial career of 'soapless soaps' was made when some research chemists in Germany observed in 1930 that cetyl sulphates and similar compounds derived from higher alcohols foam copiously in water and compare very favourably with soaps in almost all the typical 'soapy' properties. Moreover, these new compounds functioned without interference in hard water since their calcium and magnesium salts are quite soluble in water. The first 'soapless soap' was then marketed shortly in Germany by I. G. Farbenindustrie under the trade name Igeopon and in U.S.A. by the Gardinol Corporation, a joint venture of du Pont and Procter & Gamble, under the trade name Gardinol.

The textile market immediately caught upon these products as ideally suited to their purpose, and it became evident that the 'soapless soaps' despite their higher price had come to stay. In other fields, the manufacturers were quick to realise the unique advantages of these newer detergents and many now extremely popular household products like 'drene' shampoo, 'pepsodent' tooth paste, 'Duz' no-rinse dishwashing compounds, 'Draft' extra powerful detergents, brushless shaving creams, etc. were introduced in the market and they all met a ready acceptance. This warm reception is understandable as the products have unique advantages over their predecessors. For example, if soaps are used to wash hair using hard water a kind of stickly precipitate, the calcium or magnesium salt of the fatty acid, is deposited on the hais which is very difficult to remove by rinsing. This deposit gives a dulness to the hair and so in almost all modern shampoos 'soapless soaps' are used which do not dull the hair and often add a brightening effect on it.

However, these synthetic detergents and surface active agents, though the product of only an infant industry born in early thirties have already assumed quite a large tonnage. The growth can be judged from the fact that the poundage in U. .S A. has leaped from about 100 million pounds in 1940 to about 600 million pounds in 1947—not an inconsiderable figure in comparison with any other speciality chemical.

Classification and Chemistry

These synthetic detergents and surface active agents have quite a variety of chemical structure. For convenience they can be classified as follows:—

(1) Sulphated alcohols; $R\text{-}O\text{-}SO_3Na$.
(2) Alkyl aryl sulphonates; $R'C_6H_4SO_3Na$.
(3) Alkyl sulphonates; $R\,SO_3Na$.
(4) Sulphated and sulphonated amides, esters, amines, etc. $R\,CO.NH.CH_2CH_2SO_3Na$; $R\,COOCH_2SO_3Na$ etc.

(5) Cationic surface active agents ; RNH^+_3 Cl ; $RC_5H_4N^+Cl$.
(6) Nonionic soaps ; $R\ COOCH_2.CHOH.CH_2OH$, etc.
(7) Miscellaneous unclassified types ; $CH_2COO\ R.CH(SO_3Na)\ COOR$, etc.

All of them except the nonionic types have one chemical feature in common. They are derived from various types of chemical compounds on which are attached a long hydrocarbon chain usually containing twelve or more carbon atoms at some place at different point and a solubilising group such as SO_3Na, OSO_3Na, Cl etc. This feature will be noticed in the simplest type shown in the above list where R stands for a long hydrocarbon chain, usually containing twelve or more carbon atoms. In short, all soaps have both polar and non-polar groups in the same molecule and a balance between this polar and nonpolar portion *i.e.*, in the terminology of colloid chemists, the hydrophilic-hydrophobic balance, determines its soapy nature. These agents, are generally sold under various trade names and so it is often difficult to know the real chemical nature of the commercially available 'soapless soaps'.

In point of bulk production, the group (2) compounds, the alkyl aryl sulphonotes top the list contributing about half the total tonnage of the synthetic detergents. Very well-known commercial agents of this group are the Nacconols manufactured by the Allied Chemical and Dye Corporation. These have the formula $p \cdot R\ C_6H_4SO_3Na$ and are prepared by condensing an unsaturated hydrocarbon with benzene to produce $R\ C_6H_5$ which is subsequently sulphonated.

The sulphated alcohols come next in importance. They are prepared from fatty acids, and therefore ultimately from fats and oils, by reduction to the corresponding alcohol by catalytic process and subsequent treatment with sulphuric acid.

Compounds of group (4) and (5) are generally derived from fats and oils and some of them are very important articles of commerce particularly in the textile field. The cationic surface active agents are rather peculiar in having a strong germicidal action and they bid fair to replace the common carbolic acid antiseptics in many fields. We shall refer to them later.

Of group (7) two types of members need special mention ; firstly the mono-fatty acid ester of polyalcohols or polyalkylol ethers for example, glycerol monostearate and tetraethylane glycol monolaurate ; and secondly the aerosols, for example, aerosol OT which is dioctyl sulphosuccinate. It should be noted that the first type is nonionic and hence these and similar compounds are often referred to as non-ionic soaps as opposed to the usual anionic soaps and the cationic soaps (group 5 above). The nonionic soaps are extensively used as emulsifiers specially in food industries.

The history of the development of aerosol is interesting. They are quite recently developed and are one of the most powerful wetting agents known. It happened that American Cyanamide Company was stuck up with a large quantity of maleic anhydride for which they were looking for an outlet. Meanwhile, commercial production of octyl alcohol was a success in U.S.A. and this chemical also needed a role to play. The research chemists of American Cyanamide conceived the idea of esterifying maleic anhydride with octyl alcohol to produce the diester, $COOC_8H_{17}$ CH : CH $COOC_8H_{17}$, which added up sodium bisulphate, Na HSO_3 to give the desired product, aerosol OT *i.e.*, dioctyl sulphosuccinate, $COOC_8H_{17}CH(SO_3Na)$. $CH_2COOC_8H_{17}$. "It is a strange fact" observed the group leader of this research section at American Cyanamide Laboratory at Stammford, Connecticut, when the author visited them early in 1947 "that our first child has so far been the best".

Industrial Uses

The 'soapless soaps' are used for various purposes which can be roughly classified into two major groups :—(1) uses which depend on the detergent *i.e.*, cleansing action and (2) uses which depend mainly on the power of lowering the surface action. "Soapless soaps' used for the first purpose are widely and better called 'synthetic detergents' and those used for the second purpose are called 'surface active agents'. The properties of wetting action and emulsifying power are of course, derived from the surface tension depressing power of the soap though in many cases there is a lack of direct correlation between these properties owing to some specific interaction.

The scientific study of surface active agents has greatly helped to clarify our ideas of detergency and related properties. It has been demonstrated that detergent power, foaminess, lowering of surface tension, emulsifying power, wetting and dispersing action, penetrating power, solubilization power, etc., though they generally go hand in hand, are not necessarily interrelated. An agent may foam copiously but may be without much cleansing power whereas some of these newer detergents are wonderful cleansers but have only little foaming power.

A number of industries uses these agents for varied purpose very often indispensably. Naturally, textile industries top the list in volume consumption as dyeing assistants and detergents. Various processes are conducted under such stringent conditions as to make ordinary soaps totally inapplicable and hence 'soapless soaps' are usually employed and in fact, the

newer soaps have almost completely displaced the conventional ones in the speciality fields. The process in which these agents are used, to name a few, are vat and acid dyeing, bleaching, kier boiling, stripping and mercerizing, which all require some assistants composed of 'soapless soaps' as detergents, penetrants, wetting agents, lubricants etc. for successful processing. In making emulsions for the cosmetic, pharmaceutical, food and other industries where varied conditions are met with, these agents play a very useful role, often in very small concentrations sometimes for unique effects. Even chocolates do have a little of these agents to increase its 'mellowness' and to margarine is added a member of this group so as to reduce its spattering while put on the hot frying pan during cooking.

These agents are put to innumerable other uses. To mention a few, in pickling and electroplating baths, ore flotation, inks, lubricants, cutting oils and paints, mostly for their wetting and dispersing action. An unusual use is for making water 'wetter' for fire fighting. Aerosol OT of American Cyanamide Company is so powerful a wetting agent that ducks get drowned in a tank of water containing a minute concentration of this agent. It should be pointed out that these agents are used in very small concentrations generally from one per cent or so in most cases, down to even one in a million in flotation practice.

All soaps both ordinary and otherwise have the peculiar property of taking up in solution otherwise insoluble substances. This phenomenon is called solubilization and the author observed while working in Prof. McBain's laboratory in California that under favourable circumstances some of these agents such as dodecylamine hydrochloride and hexanolamine oleate are so powerful as to be able to solubilize about three times their own weight of an insoluble substance say, water in chloroform. This property is much taken help of in many industries *viz.*, cutting oil and perfumeries. A very recent development is the commercial use of a 'soapless soap', sodium xylene sulphonate to extract out lignin type materials from wood pulp leaving the cellulose almost in its native form.

The cationic soaps are quite interesting from chemical standpoint. They are mostly quarternary ammonium compounds, pyridinium compounds or alkyl betaine hydrochlorides. Typical example of the first class is lauryl dimethyl benzyl ammonium chloride, $C_{12}H_{25}(CH_3)_2(C_6H_5CH_2)N^+ \ Cl^-$, while cetyl pyridinium bromide, $C_{16}H_{33}\ C_5H_5N^+Br^-$ is a good example of the second class and cetyl betaine chloride, an antispattering agent in margarine belongs to the last class. It should be noted that in this type the soapy property is due to the cation as opposed to that in soap where the negative ion is the seat of the soapy property. As a result, these cationic soaps are not compatible with ordinary soaps or any other anionic detergents and usually they precipitate each other. These cationic detergents have the very important property of having high germicidal power, and their main uses are as antiseptic in the dairy industry, for disinfectant in restaurants and other public cooking establishments, etc. Some special compounds of this class have a phenol coefficient of nearabout 400 and above, and they are marketed in dilute solution as surgical antiseptic to replace 'lysol' and other common phenol derived compounds.

Possibility in India

In conclusion it should be pointed out that there is an enormous possibility and an unlimited scope for production of some of these useful chemicals in our country. There are very few industries where the production schedule could not be speeded up with their help. As we are big producers of oils, and as most of the steps are simple organic reactions which do not require complicated technical appliances, we must now see that the production of these important class of chemicals is considered in our basic industrial development plan. We have all the raw materials for some type. Of course the process of production and the associated technical know-how are closely guarded secrets. But it will not be at all difficult for us to develop this industry provided from now on our national government formulates a bold plan well ahead to meet this contingency.

A HOME FOR THE NATIONAL INSTITUTE OF SCIENCES OF INDIA

THE Foundation Stone of a permanent Home for the National Institute of Sciences, the premier scientific society of India, was laid on a plot of land on Muttra Road, New Delhi, by Pandit Jawaharlal Nehru, on the 19th of April, 1948. The plot is just outside the walls of Old Delhi, and faces the historic site of Kotla* Feroze Shah (city of Sultan Feroze Shah Tughlak who reigned from 1351-1388 A.D.). The site is between Old Delhi, and the official town of New Delhi, and its choice is symbolic of the union of official and non-official life, of the meeting of representatives of science, and of government officers in the metropolis of India.

The new Home when completed will contain the administrative offices of the Institute, offices for publication, lecture halls, meeting and committee rooms, library and reading rooms, and quarters for assistant secretary who will be the chief administrative officer of the Institute, and quarters for other members of the staff. It is also intended to have some other residential rooms for the occasional use of Fellows who may be visiting Delhi and for distinguished foreign guests. In its Fellows, publications, and libraries, the Institute will have a 'pool of knowledge' which will be extremely useful for the Government in these days, when science is penetrating almost every walk of life.

We notice that there is a certain amount of confusion regarding the functions of the Institute, as is evident from the Premier's speech on the occasion, in which he deprecated the founding of such an Institute at the capital city, the atmosphere of which in his opinion was not stimulative for any creative work. This misunderstanding is due to the unfortunate use of the word—'Institute' in a number of different senses and we are sorry that the distinction was not made clear earlier to the Premier. The proper name for the National Institute of Sciences of India should have been the 'National Indian Academy of Sciences'.

The 'National Institute of Sciences' in spite of its name, is not a *research institute*, but its functions are similar to those of the "L'Institute Francaise" which co-ordinates the activities of the four national academies of France. The historic reasons for the choice of the name 'Institute' which in India is used in a different sense (meaning a research place with a laboratory attached) is explained in the inaugural address of the First President of the National Institute, Sir Lewis L. Fermor (see extracts quoted below) in January, 1935, at Calcutta. The functions of the National Institute of Sciences are similar to those of the Royal Society of London, or the National Academy of Sciences of Washington, (both situated at the metropolis) which are recognised by the respective governments of these countries as the most representative body of scientists, with the right to be consulted on all matters of scientific policy, or application of science to national life. These rights have been conceded by the Government of India to the National Institute of Sciences in 1945 (see SCIENCE AND CULTURE, November, 1945, p. 291) and it was at the suggestion of the Government of India that the National Institute moved to Delhi from Calcutta which was its head-quarters for the first ten years. This shift was agreed upon with the concurrence of the whole body of Fellows of the National Institute of Sciences, comprising nearly 300 of the most eminent scientists of India.

Regarding conventional type of research institute to which laboratories, field stations and workshops may be attached, we appreciate very much the remarks made by the Premier. There has been a tendency in recent times on the part of many officials and also of many scientists that important Research Institutes should be located near about Delhi. The worst example is probably the location of the Agricultural Research Institute at Delhi which was done more than 10 years ago at the insistence of Sir Fazli Hussain, then a member of the Government of India, in spite of almost unanimous protests of the scientists of India. We think that after the declaration by the Head of the State, a rational view of the location of the Research Institutes should be taken. Delhi may be selected if found suitable from the scientific and other points of view, but not because it is the metropolis of India.

We regret to find that the Premier has somehow been led to think that eminent scientists of India are being attracted to Delhi either on account of service or high prospects of salary. On the contrary we know that many eminent scientists declined to leave their posts either for the sake of power which an office at Delhi confers on the holder or on account of the emoluments attached to it. We are also further of opinion that many eminent scientists and other professional non-civil service men who have been called lately to the Government of India are absolutely necessary if the National Government is to perform its duty towards the country. The work

* The Kotla contains a famous Asoke Pillar, containing a long inscription of the Emperor Asoke (269 B.C.—233 B.C.), which Feroze brought after a great exertion from a village about 18 miles to the east of the city, where it was originally mounted.

done by these men cannot be discharged by Civil Servants as has been found in the case of many other countries. We propose to discuss these points in a longer article to be published in a subsequent issue of our journal.

Extracts from the Inaugural address to the National Institute of Sciences of India on "The Organization of Scientific Research in India" by Dr (now Sir) L. L. Fermor, the first President of the Institute, held in Calcutta in January, 1935.

Referring to the developments of science in the present century leading to the foundation of the National Institute of Sciences of India, Dr Fermor referred to the birth of science during the golden age of Greece in the period 450 to 400 B.C. in Athens, to the period of darkness that descended upon the world after the break up of the Roman Empire, until the Renaissance or rebirth of learning in Europe in the 13th to 16th centuries, leading to the foundation of the Royal Society of London in 1660 and of the *Académie royale des sciences* in France in 1666. The French Academy of Sciences now forms with four other Academies for other branches of learning what is now called the *Institute of France*, but which, at an earlier stage of its existence, had a longer title, namely *L'Institut nationale des sciences et des arts*, that is to say, 'The National Institute of Sciences and Arts'.

Development of Scientific Research in India in the Twentieth Century

Reviewing the development of Science in India during the present century, Dr Fermor referred to the formation of the Board of Scientific Advice in India in 1902 by the Government of India, that suspended its activities in 1924. Since then development of scientific research in India, is a period characterised by the formation of numerous specialist scientific societies, services, universities and numerous research institutes, devoted to the specialised Study of Sciences. In the matter of specialist scientific societies the geologists gave an early lead with the foundation of the Mining and Geological Institute of India* in 1906. The Indian Mathematical Society was started in 1907 in Poona as the Indian Mathematical Club; followed by the Institution of Engineers (India) founded in 1921, with its headquarters in Calcutta, the Indian Botanical Society, founded in 1921 with a peripatetic headquarters, the Indian Chemical Society, as also the Geological, Mining, and Metallurgical Society of India founded in 1924 with its headquarters in Calcutta; and three other All-India societies founded in Calcutta, namely the Indian Physical Society, the Indian Society of Soil Science, and the Indian Physiological Society. There is also the Society of Biological Chemists founded at Bangalore and the Institution of Chemists (India) founded in Calcutta in 1927; and of societies of more restricted geographical scope, he mentioned the Calcutta Mathematical Society founded in 1908.

In addition to the Government scientific services supported by funds from Central Revenues, Dr Fermor referred to the several research institutions similarly supported. In chronological order of foundation they are the Imperial Institute of Veterinary Research at Mukteswar, which commenced life as the Imperial Bacteriological Laboratory at Poona in 1890, moved to Mukteswar in 1893, and assumed its present title in 1925; the Imperial Agricultural Research Institute at Pusa (1903) removed to New Delhi in 1935; the Central Research Institute at Kasauli (1906); the Imperial Forest Research Institute at Dehra Dun (1906); and the All-India Institute of Public Health and Hygiene in Calcutta (1934). There are also several other well-known research institutions principally medical, provincially administered, at which high-class research work is in progress, *e.g.*, the School of Tropical Medicine, Calcutta, and the Haffkine Institute, Bombay.

Further, there is the Indian Institute of Science at Bangalore founded in 1911 and supported mainly by private bequests supplemented by Government grants and directed to research and advanced scientific education.

Earlier 'The Asiatic Society' was founded in 1784, for the study of the antiquities, arts, sciences and literature of Asia, that led to the foundation of the Indian Museum and various scientific departments of the Government of India. The Asiatic Society of Bengal was followed by the establishment of two pure Scientific Societies in the nineteenth century *viz.*, the Indian Association for the Cultivation of Science in 1876 and the Bombay Natural History Society in 1883.

Co-ordinating Organization

With this multitude of new bodies—services, societies, universities, research institutes—coming continuously into being, with a resultant tendency towards greater and greater specialisation and consequent isolation of workers, there is an increasing need for organisations directed to counteracting fissiparous tendencies so as again to bring men of sciences and other branches of learning back to a common fold providing for a free exchange of views: a result that can be secured either on a comprehensive basis enabling the co-operation of all branches of learning, or at least of all branches of science, or upon a compartmental plan in which allied groups

* Now known as "Mining, Metallurgical and Geological Institute of India".

of sciences are brought together. At the beginning of the present century the only organisation directed to this end in a really comprehensive manner was the Asiatic Society of Bengal.

Indian Science Congress Association

The isolation of certain scientific workers, referred to above, is partly due to the geographical isolation of those who live in places where there are but few scientists, and partly the specialist isolation of large numbers of scientists one from another due to their specialisation. In order to counteract to some extent both forms of isolation the formation of an Indian Association for the Advancement of Science, analogous to the British Association was thought of. As a result, the Indian Science Congress was born, the inaugural meeting being held in 1914 in the rooms of the Asiatic Society of Bengal under the Presidentship of Sir Ashutosh Mookerjee. This Congress, which has since become an Association, meets annually, moving from one important city to another on a plan analogous to that adopted by the British Association. The great success of this organisation is shown by the large numbers of scientists from all parts of India who now attend the annual sessions and the corresponding magnitude of the annual volume of published Proceedings. Although in its annual activities the Association is peripatetic, yet it requires a permanent office, and this, in fact, is provided in Calcutta by the Asiatic Society of Bengal.* There can be little doubt that the Indian Science Congress has proved of very great benefit in promoting intercourse between the scientists of all parts of India and all sciences, thereby mitigating both forms of isolation. But this Association meets only once a year, and it is for one week only during 52 that scientists are afforded the opportunity for this fruitful intercourse. During the rest of the year, the centres of research tend to remain in geographical isolation one from another, and at those centres, particularly at the large ones, the scientists return from the Congress to their specialist isolation, making use as far as possible of specialist societies.

The Academies

There is no doubt that there is a great need for the existence, at the important centres of scientific research, of bodies in which workers in various branches gather not for the reading of specialised papers dealing with minor details and specialist problems, but for the reading and discussion of papers with broader outlines and for the interchange of views. This brings us to the Academy.

The original Academy dated from about 400 B.C. and was a garden utilised for philosophic teachings and discussions. It was essentially a place where any branch of knowledge could be discussed, and was completely different from our specialised societies to-day. In this original Academy the old philosophers must have discussed arts and letters, mathematics, and science, as well as philosophy strictly so called ; so that a true Academy, without qualification, should be on as broad a basis. The Asiatick Society, now the Asiatic Society of Bengal, is one of the few institutions that complies with such a definition, and it is essentially an Academy of arts, letters, philosophy, and sciences.

While Academies, if we go to the original meaning, must, therefore, function locally or regionally in the most important portion of their activities, they can also legitimately make a wider appeal ; for now-a-days Academies also undertake the publication for general information of the results of original researches carried out by their members, and for this reason Academies may legitimately expect to secure a wider membership than only local utility would encourage. The Asiatic Society of Bengal, has as the result of its researches secured a membership that is not only all-India but international. Nevertheless the major benefits of its activities accrue to those who are within easy reach of its headquarters, and eventually the Society has had added to its name for purpose of identification a territorial or local designation, so that it is now called the Asiatic Society of Bengal, in the same way as the Royal Society is the Royal Society of London as distinct from the Royal Society of Edinburgh. In practice, however, the Asiatic Society cannot hope to cater for the frequently recurring (say monthly) needs of the whole of India and, therefore, can have no feeling of jealousy towards other bodies of Academy rank founded in other parts of India.

The United Provinces Academy of Sciences*, founded at Allahabad in 1930, was, therefore, on this argument, a desirable creation to provide for the meeting of students of all branches of science in Northern India.

Similarly the Indian Academy of Sciences founded in 1934 at Bangalore provide 'a philosophers' garden for Southern India.

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* Since 1935 the office of this Association was located successively at the University College of Science & Technology, and the Presidency College, Calcutta. It was again removed to its original house at the Royal Asiatic Society of Bengal in 1947. There has been efforts to remove this office to New Delhi but we feel there can be no justification for this transfer.

Ed : *Sci. & Cul.*

* Now known as 'National Academy of Sciences of India'.

National Institute of Sciences of India

But we still needed a co-ordinating body ; and that is why it was necessary to found the National Institute. Obviously this co-ordinating body should not compete with the Academies in such a way as to harm them. The prime function of the Academies is to arrange for regular meetings for philosophic discussions on a suitable periodic basis, say monthly, and for the regular periodic publication of the results of these meetings and discussions, in so far as they are worthy of publication to the world at large. With these activities of the Academies our National Institute should have as one of its major activities the co-ordination of the labours of the various Academies. We can picture one day when there may be a *National Institute of Letters*, and *National Institute of Arts* and there will be a need for co-ordinating the three National Institutes into a National Institute of Arts, Letters, and Sciences of India, which would be the *Institute of India* equivalent to the *Institute of France* in its comprehensive scope.

The aims and objects of our National Institute would be :

(*a*) To co-ordinate the labours of the scientists in India,

(*b*) to effect co-operation between the various bodies of Academy rank,

(*c*) to render possible the formation of a National Research Council,

(*d*) to publish annually a review of the progress of science in India, and

(*e*) to promote special meetings for the purpose of arranging discussions, by scientists of allied sciences, of problems of joint interest.

Headquarters of the National Institute

Past history and present facts obviously point to Calcutta as the head quarters of the Institute. But had our new society been another Academy in the sense used in this address, I should not have advocated the selection of Calcutta as its headquarters, for there is no room for two Academies of similar aims in one city. Another possibility, and one which was briefly considered, was that of establishing the headquarters of the new body at Delhi, the official capital of India. The total number of scientists resident at Delhi, however, seemed to render this undesirable. The third possibility was an amalgamation with the newly established Academy of Science at Bangalore ; but this became clearly inadvisable once it was realised that there were already two other Academies of Sciences in India with claims prior to those of the Academy founded at Bangalore. The fourth possibility was for the National Institute to function as a peripatetic body with its headquarters moving every two years according to the change of President. This possibility was considered, but the Academy Committee decided that business requirements and the best interests of the Institute necessitated that the headquarters should be located definitely in one particular centre of research. The provisional rules did not name any place as the headquarters and there was nothing to prevent a change of headquarters at any time should the interests of the National Institute render this desirable. Meanwhile convenience and common sense appeared to require that to begin with, locate the office of the Institute in Calcutta. *

* The headquarters of the Institute removed to Delhi in 1946, as suggested by the Government of India and agreed upon by the entire body of Fellows.

Ed : *Sci. & Cul.*

ON DEFENCE OF SCIENCE

"What hopes and fears does the scientific method imply for mankind? I do not think that this is the right way to put the question. Whatever this tool in the hand of man will produce depends entirely on the nature of the goals alive in this mankind. Once these goals exist, the scientific method furnishes means to realize them. Yet it cannot furnish the very goals. The scientific method itself would not have led anywhere, it would not even have been born without a passionate striving for clear understanding. Perfection of means and confused goals seem— in my opinion—to characterize our age. If we desire sincerely and passionately the safety, the welfare, and the free developments of the talents of all men, we shall not be in want of the means to approach such a state. Even if only a small part of mankind strives for such goals, their superiority will prove itself in the long run."—Albert Einstein.

Notes and News

ATOMIC RESEARCH WITH ONE MILLION VOLTS

A new, atom-smashing, linear accelerator with which energies of one million volts have already been produced, has been constructed in the Yale University. Instead of using heavy particles of matter to smash the atom, this linear accelerator works on the principle of using the electron to smash the nucleus. The method of operation of the linear accelerator is the firing of electron particles in a straight line through a series of 'pill boxes' made of steel and lined with copper to provide maximum conductivity. These pill boxes, termed "Cavity resonators", connect with high-powered amplifiers and the flow of electron particles from a single external source is synchronized by a master amplifier. Other linear accelerators now in existence have to depend on individual self-excited oscillators and require high machining tolerances so the pill boxes fit together exactly. The heart of the system, the pill box, is relatively inexpensive.

Prof. Schultz and his collaborators are now building a pilot model at the Yale Sloane Physics Laboratory which is expected shortly to produce energies from 15 million to 20 million volts. The series of pill boxes will measure from 5 ft. to 6 ft. in length. In operation the pill boxes are evacuated of air and this vacuum is maintained during all experiments. An "electron gun" in the form of a high-voltage vacuum tube, emits streams of electron particles into the pill boxes which start at relatively low speeds of 5000 volts and build up to multimillion voltages depending on the number of pill boxes which are used. (*The Chemical Age*, March 6, 1948.)

TRITIUM—THE HYDROGEN ISOTOPE OF MASS THREE

The search for tritium in nature started almost as soon as deuterium was discovered, since tritium is considered as a possible reaction-product in nuclear processes taking place in the atmosphere of the earth. Deuterium, the hydrogen isotope of mass two was first detected by a spectroscopic method by observing faint lines in the Balmer spectrum that were separated from much more intense lines by an amount predicted by theory for a hydrogen atom of mass two. It was also possible to predict from theory the displacement of the tritium lines from the main lines of light hydrogen. In 1934, Oliphant, Harteck and Rutherford used high energy deuterons (ranging up to several hundred thousand electron volts) to bombard deuterium atoms in target compounds and observed a pronounced emission of protons as well as neutrons as products of the reaction. They also postulated two possible nuclear reactions.

$$\underset{\text{deuteron}}{D_1^2} + D_1^2 \longrightarrow \underset{\text{tritium}}{H_1^3} + \underset{\text{proton}}{H_1^1}$$

$$\underset{\text{deuteron}}{D_1^2} + D_1^2 \longrightarrow He_2^3 + \underset{\text{neutron}}{n_0^1}$$

In 1939, Alvarez and Cornog bombarded deuterium gas with high speed deuterons and passed the resulting gas mixture into an ionization chamber connected to an amplifier. Any radioactivity in the gas would initiate ionization in the chamber and be registered as an ionization current. The gas showed a definite activity of long half life. They proved that the activity was associated with hydrogen molecules and also showed that the particles emitted by the radioactive atoms had a very short range and therefore low energy. These investigators concluded that the radioactive tritium was formed according to the above equation.

In 1940, O'Neal and Goldhaber found that beta particles having an energy of 13,000 ± 5,000 electron volts were emitted from an 'aged' beryllium cyclotron beam target that had previously been bombarded with one million electron volt deuterons. From the magnitude of the beta particle energy the activity appeared to be due to tritium. They postulated that the tritium could have been formed by the reaction

$$Be^9 + D^2 \longrightarrow Be^8 + H^3$$

They showed that a radioactive gas could be extracted from the beryllium target either by heating the latter or by dissolving it in sulphuric acid and that the half life of tritium was 31±8 years. Brown found that the beta particles emitted by tritium can penetrate only 13±1 mm. of helium gas at atmospheric pressure. Later in 1941, O'Neal confirmed this value and gave more reliable value for beta particle energy as 15,000±3,000 electron volts. Thus from all these investigations it was concluded that less than one atom of tritium is present in 10^{12} atoms of ordinary hydrogen.

Recently (January, 1948) Maxwell Leigh Eidinoff developed a method which consisted essentially in

determining the number of beta particles emitted per unit time in a space containing a known number of hydrogen atoms and showed that there is less than one tritium atom in 10^{17} atoms of ordinary hydrogen. (*Journal of Chemical Education*, January, 1948, p. 31).

A NEW USE OF DIAMOND

In the National Bureau of Standards, Washington, use is being made of a new type of very sensitive detector of γ-rays emitted by radioactive substances.

A small piece of diamond is interposed between two pieces of brass electrodes kept at a potential difference of about 1000 volts. When a γ-ray passes through the diamond a pulse of current is produced which after amplification can be detected by the usual methods (counter, oscillograph or loud speaker).

It is thought that the property of diamond to give current pulses under the action of a γ-ray is due to the great symmetry in the crystalline structure, characterized by a regular distribution of carbon atoms in its molecule with relatively large gaps. According to this theory when an electron is emitted by an atom due to absorption of γ-ray, the liberated electron is accelerated in the interatomic space towards the positive electrode.

Within a very small distance, it acquires such a high velocity that the other atoms that it meets in its path are ionized by collision with the electron and they also lose some electrons which in their turn are also equally accelerated in the same direction.

This multiplication of charges repeats at a large speed and there results a regular swarm of electrons falling on the positive electrode, equivalent to a small current pulse. The larger the diamond is, more electrons there will be at the end of the swarm, so much so that the sensitivity to the γ-rays is proportional to the size of the crystal. However, small diamond sizes are very convenient. This counter of new type returns to its original condition very quickly. Its sensitivity is far greater than that of the G-M counter.

The γ-rays can also produce this effect in other crystalline substances such as NaCl but in most cases these crystals should be cooled to a very low temperature in order to eliminate the ionization parasites which occur at ordinary temperature.

Diamond is the only substance which can function properly even at ordinary temperature. It should be colourless and absolutely free from defects.

CLIMATE MAKES THE MAN

During the last World War a considerable amount of work was carried out in attempts to protect the troops from injurious effects of climate. Considerable improvements were attained in the protection of an individual against cold, a problem which received much attention because it affected all the three services,--the Air Force, the Navy and the Army. The ill effects of heat were also seen in the tropics but much less success was attained in overcoming them. The ill effects of heat were demonstrated on ship board during the war. A naval vessel blacked out and closed down for action in the tropics, attained temperatures 10°F or more, above that of the external tropical environment and also developed high humidity. The effect on human efficiency was often serious. In the early years of the war these bad effects were particularly in evidence in British submarines in the tropics, and it is probable that some of these ships were lost as the result of high temperatures alone. The crews of British submarines in the tropics were the least healthy of the whole Eastern Fleet and had the lowest morale. American submarines fitted with air conditioning units had no such record. Later the Admiralty had air-conditioning installed in all British submarines assigned to tropical service and at once the crews changed to become the most healthy of the whole fleet and with highest possible morale.

Cardiovascular diseases in old people are commonly associated with high blood pressure, and they are responsible for a high proportion of deaths, often dependent on cardiac failure, coronary disease or cerebral haemorrhage. All of these complications appear dependent on failure of physiological adjustments rather on mere chance infections. The cases o cardiac failure are minimum in the hottest months of the summer and in the coldest months of the winter and maximum in the spring and autumn.

The average child, whether white or coloured, cannot be expected to study well, either in school or at home, under unduly hot conditions. In a bamboo hut, with no windows and only blinds to exclude insects, maintained at a temperature which results in persistent sweating, there is little inclination to do mental work. Not only is education difficult but deterioration is apt to be observed even in well educated adults. Nor are the natives entirely immune to such effects. Their energy and initiative are reduced. For adequate development of the worst areas, drastic changes in the present housing situations are required.

It would be impossible to imagine a modern civilization flourishing in northern areas if the housing were limited to bamboo huts. For the proper use of schools, scientific laboratories, rooms for mechanical drawing, shops for *lathe* or similar machine work, etc. all of which are essential both for education and industry, centrally heated buildings are needed in cold climates, and air-conditioned

buildings are equally essential in the tropics. Austerity is good for character but in Britain it is realized that over-cold rooms and inadequate supply of electric power for light do not promote the growth of civilization, nor aid in the education of children. Similarly in the United States in the absence of air-conditioning in the schools it is recognized that it would be inefficient to force the children to attend school throughout the intense heat of the summer.

India teems with a population which is rapidly expanding, and continually outgrows its resources. She has a proud history. In spite of a very difficult climate she has racial stocks of proven high intellectual capacity. Without the development of large industries and the use of more scientific methods in agriculture, she cannot hope to support her rapidly growing population. If air-conditioning of homes can be more effective than that of factories, she needs to know it, for such a change would require a revolution in her normal customs. India, one of the birth places of civilization, has suffered in competition in the absence of technical skills for the control of hot climates. Now that these technics have been made available, who can tell what future may lie before her?—(*The Advancement of Science*, 4, 348, 1948).

ATOMIC MACHINE FOR OXFORD UNIVERSITY

A BETATRON (atom-splitting machine) representing a bold departure in design is being installed in an underground room of the Clarendon Laboratory of the Oxford University.

The principle of the betatron is to accelerate, by means of a rapidly changing magnetic field, electrons fired into a hollow evacuated ring shaped tube, which the Americans call a doughnut. In this machine the doughnut is very much smaller than usual, only *about an inch across*, so that great economy of material is possible. As electrons travel round in this tube about a million times—nearly 1,000 miles—without hitting the sides, it is a great technical achievement to have reduced the cross-section so much.

This new instrument puts at the disposal of scientists more energetic electrons than have been available in university laboratories hitherto. The high energy may also be of great value for the treatment of disease.

ANHYDROUS AMMONIA AS A FERTILIZER

THE direct use of anhydrous ammonia to the soil as a means of nitrogenous fertilization started with the investigation into its feasibility in 1941. It was found that when properly applied the ammonia dissolved in the moisture of the soil. The mixture combined with the clay to a degree that prevented its loss by natural washing away. From the system the ammonia came off at a rate sufficient to supply the crops with the necessary nitrogen. Until the last 200 years, most fertilizer was of the organic variety which was ultimately supplanted by Chile saltpetre, ammonium sulphate, sodium nitrate and urea.

NUTRITION BY NATURAL FATS

IN a feeding experiment with young white rats the fat in the balanced diet was varied in quality and the growth was compared. The increase in weight in eight weeks when the fat was butter fat, was the standard, 100 per cent, palm kernel oil induced 98·6, palm oil 96·9, cocoanut oil 93·2, salad oil 91·8, hydrogenated sardine oil 84·3 percent. Hence nutritionally natural fats are far superior to processed fats and almost as good as butter fat.

FLOATING AERODROME

STOCKHOLM proposes to construct a floating airport which will be the most unique of its kind in existence. This airfield will be located on the surface of Stora Vartan, an island lake not more than six miles from the town centre of the capital.

The principle of founding bodies heavier than water on an elastic surface has been recognized as technically sound and their applications in the form of "floating bridges" have been successfully carried out in America and Australia. On these principles the eminent engineer Dr A. Frey Samsloe has carried out preliminary research into the question of elastic resistance, construction methods and cost for floating structures for the proposed aerodrome. Favourable opinions on this singularly novel method of construction, have also been expressed by some of the English and American aviation experts to whom the scheme was submitted for scrutiny.

The runways for this aerodrome will be 365 feet wide and 160 feet long, will consist of cross-armoured slabs of first-quality concrete, constructed in a kind of dry dock to maintain homogeneity. These slabs will rest on a primary girder work, spaced at 23 feet, and spanned by secondary slabs between them. The surface cannot float directly on the water as any leak might cause the whole floating structure to sink. It is therefore suggested to support the quadrangular cells formed by the primary and secondary

girder work, by a cushion of compressed air between the flat surface and the water. Inevitable small losses would be compensated by continuously inducting compressed air in small quantities through a system of perforated air pipes below water level. Each of the cells would have a vertical air duct which would communicate with the free air, and be made just as long as the float surface is meant to remain above the water level. If and when the increasing pressure of compressed air begins to displace the water below the bottom level of the air duct, the latter will act as an automatic safety valve through which the surplus air will escape. In this way the surface will be kept at a constant level and the whole aerodrome maintained as a stable unit.

Among the many new developments now taking place in aeronautical sciences, the evolution of this novel floating plane base will rank as a landmark in air field construction and may possibly set up new standards and specifications in the field of reinforced concrete and steel construction. (*Teknisk Tidsskrift*, Sweden (March 22, 1947.)

S. K. G.

EXPLORING THE UNKNOWN

In 1934 Dr Charles William Beebe of the New York's Zoological Society descended under water to a depth of 3028 feet near Nonesuch Island, Bermuda. His spherical diving chamber "Bathysphere" was made of steel 1¼″ thick and only 4′ 9″ in diameter. It was lowered by a steel cable from a parentship *Gladisfen*. That was the limit that man had ever gone under sea.

Recently Prof. Augste Piccard and Dr Cosyns has planned to descend to greater depths of the ocean. Their craft "Bathyscaphe" as they called it, is a submarine craft of extraordinary design, contains a hermetically sealed alloy-steel sphere 6½′ in outside diameter. Its walls are 3½″ thick, and could resist the water pressure of 5,700 lbs. to a square inch. The port holes are of a transparent material, 16″ in diameter outside and 4″ inside. The craft is independent of any kind of help from the parent ship. The men inside the globe can control its ascent and descent at will. Seven aluminium cylinders contain a fluid lighter than water for buoyancy float. Prof. Piccard has chosen aviation gasoline for this purpose, a cubic foot of which weighs 20 lbs. less than that of water; so that a lifting force of 10 tons is obtained by 1000 cubic feet gasoline. This will surely be more than sufficient to counter-balance the sphere's weight. The bottoms of the cylinders are kept open to equalize the pressure inside and out and so to obviate any need for heavy armoured walls.

The bathyscaphe would appear to have an ample margin of safety but all sorts of problems are involved not the least being the making of water-tight joints in the structure. At a depth of 13,000′ there will be a titanic crushing force of 72,000 tons upon its spherical shell. It has been calculated that a hole 1 sq. mm. would allow as much as 22 pints of water a minute to rush in, with a tremendous speed of 300 yards per second.

Dr Piccard and Dr Max Cosyns have selected their point of descent near Ivory coast off North Guinea (Africa). A 4,000 ton ship *Scaldis* lent to the professor by the Belgian Government contains radar equipment to keep in touch with the bathyscaphe. The depth of the water there is about 19,000′ so that the test dives could be made to 1½ times the depth to which the explorers themselves would go.

Equipment of the submarine *Gondola* will provide every scientific facility for observing marine life at extreme depths. Deeper still they would collect samples of water and by a motion picture camera would photograph strange denizens of the deep illuminated by 3,000 candle power under sea lamps. They would be able to catch fishes by means of their electromagnetic harpoons. Plan calls for an undersea journey lasting 8 to 10 hours. For this purpose oxygen tanks in cabin provide an ample supply. The exhaled carbon dioxide will be absorbed with soda lime and absorbing excess humidity with silica gel. A recording water pressure gauge will record the greatest depth reached by bathyscaphe. In case of any ship-up the bathyscaphe is equipped with radio, flares as well as rockets to signal its surface location. It is brightly painted with orange colour so that, if necessary search planes might find it easily.

Before they left for the Ivory coast in the parentship *Scaldis* adventurers declared that their first object was to study the disintegration of the sunlight in the depths. Despite every possible precaution, however, the adventurers are well aware that their first descent will be a gamble with death. They are prepared to accept all the hazards.

S. Z. R. H.

NEW FELLOWS OF THE ROYAL SOCIETY

The Royal Society has elected the following into the Fellowship of the Society:—

Thomas Edward Allibone, Director, Research Laboratories. Associated Electrical Industries; distinguished for contributions to application of high-voltage phenomena.

Frank Philip Bowden, Lecturer in Physical Chemistry, Cambridge University; distinguished for contributions to study of friction and lubrication.

Hayne Constant, Deputy Director (Research), National Gas Turbine establishment; distinguished for studies in applications of thermodynamics and aerodynamics to aircraft engines

Stanley Fabes Dorey, Chief Surveyor, Lloyd's Register of Shipping; distinguished for contributions to marine engineering.

Ernest Harold Farmer, Assistant Director and senior organic chemist, British Rubber Producers' Research Assoc.; distinguished for experimental studies of complex unsaturated hydrocarbons and related natural products.

Otto Robert Frisch, Jacksonian Professor of Natural Philosophy, Cambridge University, distinguished for researches on fission processes in nuclear physics.

Sir John Claud Fortescue Fryer, secretary of the Agricultural Research Council; distinguished for services to agricultural science and contributions to applied entomology.

Thomas Maxwell Harris, Professor of Botany, Reading University; distinguished for researches in palaeo-botany.

Walter Heinrich Heitler, Senior Professor in the School of Theoretical Physics, Institute for Advanced Studies, Dublin; distinguished for contributions to theoretical physics.

Alan Lloyd Hodgkin, Assistant Director of Research in Physiology, Cambridge; distinguished for researches on the nature of nervous conduction.

George Martin Lees, Chief Geologist to the Anglo-Iranian Oil Co.; distinguished for contributions to stratigraphical and structural geology, particularly in relation to oilfields.

Robert Alexander McCance, Professor of Experimental Medicine, Cambridge University; distinguished for contribution to metabolic studies of human beings.

Kurt Mahler, Senior Lecturer in Mathematics, Manchester University; distinguished for researches in the theory of numbers.

Sidnie Milana Manton, Lecturer at King's College, London; distinguished for her work on the crustacea and other invertebrates.

Dorothy Mary Needham, Biochemist, School of Biochemistry, Cambridge University; distinguished for researches on the biochemistry of muscle.

Jamts Herbert Orton, Professor of Zoology, Liverpool University; distinguished for investigations in marine biology.

Sir Leonard Gregory Parsons, Emeritus Professor of Diseases of Children, Birmingham University; distinguished for studies on child health and the wasting disorders of children.

Stanley Peat, Reader in Organic Chemistry, Birmingham University; distinguished for contributions to constitution and synthesis of carbohydrates.

Gilbert Wooding Robinson, Professor of Agricultural Chemistry, Univ. College of North Wales, Bangor; distinguished for contributions to study of soils.

William Albert Hugh Rushton, Univ. Lecturer in Physiology, Cambridge; distinguished for researches on the effect of electrical stimuli on muscles and nerves.

John Walter Ryde, Senior Physicist, Research Laboratories, General Electric Company, Wembley; distinguished for contributions to pure and applied physics.

George Robert Sabine Snow, Fellow of Magdalen College, Oxford; distinguished for work on plant hormones and growth.

Edger William Richard Steacie, Director, Division of Chemistry, National Research Council, Canada; distinguished for researches on gaseous chemical reactions.

John Arthur Todd, Lecturer in Mathematics, Cambridge University; distinguished for researches into the geometry of figures.

Frank Yates, Chief Statistician, Rothamsted Experimental Station; distinguished for contributions to statistical analysis of agricultural problems.

DAKSHINA RANJAN BHATTACHARYYA

PROF. D. R. BHATTACHARYYA, Head of the Department of Zoology in the Allahabad University, who was recently appointed its Vice-Chancellor, is connected with this University since 1904. He graduated in Science with a Government Scholarship from the Muir Central College in 1908 and was the first to obtain the Master's degree in Zoology from the Allahabad University. Later, he proceeded to Europe, where he obtained his Ph.D. from the Trinity College, Dublin in 1924 and Sc.D. (State Doctorate) from Paris in 1925. A keen sportsman, Dr Bhattacharyya captained several hockey teams and often played at Tennis and Cricket tournaments.

Prof. Bhattacharyya joined the U. P. Educational Service in 1910 as a professor of Zoology at the Muir Central College and holding charge of the Department of Zoology of the Allahabad University since 1921. He was elected Dean of Faculty of Science from 1926-1932 and 1935-1938.

Prof. Bhattacharyya is a Fellow of the Zoological Society of France, the National Institute of Sciences of India, the Indian Academy of Sciences and the National Academy of Sciences of India. He was elected president of the latter body in 1940-42, and

also presided over the Zoology Section of the Indian Science Congress Association in 1932. He has published a large number of original papers in Zoology and his contribution to cytology, Ichthyology and Morphology are outstanding.

Dr Bhattacharyya has worked a great deal in popularizing Music in Northern India. As president of the Music Association of the Allahabad University he has succeeded in establishing a Department of Music and helped in the growth of the athletic association and womens' education in the Allahabad University.

ANNOUNCEMENTS

DR. GILBERT FOWLER of Bangalore, (S. India) has been elected an Honorary Fellow of the Institution of Sanitary Engineers in recognition of his services to sanitary science, particularly in connection with the activated sludge process of sewage purification. He has also been elected an Honorary member of the Engineers' Club of Manchester, England, of which he is a foundation member.

THE foundation stone of the "Institute of Nuclear Physics" in the University College of Science and Technology, Calcutta was laid on April 21, by the Hon'ble Dr. S. P. Mookerjee, Minister for Industry and Supplies, Government of India. A fuller account will appear in our next issue.

DR P. K. SEN GUPTA, Horticulturist to the Government of Bihar and Professor of Horticulture, Bihar Agricultural College, Sabour, is appointed Khaira Professor of Agriculture in the Calcutta University. It may be recalled that this chair has been vacant since 1931, when Dr N. Ganguly, (a member of the Royal Commission on Agriculture, in India, 1926-28) resigned. Dr Sen Gupta's works on the water requirements of rice plant and investigation into the causes of the necrosis of many are outstanding.

BOOK REVIEWS

The New Fibres—By J. V. Sherman and S. L. Sherman, D. Van Nostrand & Co., Inc., New York, 1946. Pp. 521. Price $5·00.

Synthetic fibres like synthetic petrol or synthetic rubber are no longer chemical curiosities to the scientists, or strangers to man in the street. Nylon is almost a household word today just as artificial silk. But we have today too many of the man made fibres and confusion naturally arises regarding their identity or composition. Newer ones are making their appearance in so rapid succession that it has become rather difficult even for the textile technologist to remember them accurately. The book under review is a very welcome addition to the meagre stock of treatise on textiles and will be helpful to the lay man in understanding easily these novel articles. An important feature of the book is the comparative tables of constants of the new fibres arranged side by side with those of natural ones. These will be useful to the textile chemist or physicist in evaluating the fibres correctly for any particular purpose. The long list of U. S. patents covering more than 150 pages seems to be of little value to the common man.

The synthetic fibres together do not however constitute even one per cent of all the textile fibres used in the world but this by no means detracts the value or importance of the book for in near future they are expected to play a more extensive role in our every day life.

P. B. S.

Freedom Under Planning-By Barbara Wootton. Publishers: George Allen & Unwin Ltd., London, 1945. Pp. 1—63. Price 6*s*. net.

The author first of all attempts to define what is meant by cultural and civil freedom and to what extent planning may interfere with these. She then examines how far the consumer is free under existing conditions and also in a planned society to spend or obtain goods desired. The freedom of the producer is examined from the standpoint of the worker, with regard to choice of employment, of the entrepreneur regarding production at his end and the freedom enjoyed in the mutual relation of the employer and the employed in the matter of collective

bargaining. Mrs Wootton has tried to analyse impartially but not in a detailed fashion the facts available to her to ascertain how far planning or lack of plans will lead to greater freedom or tyranny. It is however difficult to reconcile her general logical treatment with statements like "As the years pass, however, it becomes harder and harder to relate each of the British political parties to a specific group of economic interests". It would be more correct to state that the complex character of present day economic interests ought to lead to a realignment of parties (*e.g.* a good deal of Labour ought really to be "Conservative") on the basis of a broader and more realistic classification, linked to interests at home and abroad. There is another point which seems to have been overlooked by the writer. The U.S.S.R. and the great capitalist States have been continuously at war in the economic plane and it is not right to consider such "wartime" conditions to be equivalent of peacetime plans and results. Mrs Wootton has rightly laid stress on the safe guards needed under planning. As she notes at the end, "The last and greatest defence of freedom under planning lies in the quality and attitude of the people". It is on their informed alertness and courage that the safeguards of freedom depend for their strength.

K. P. C.

Flowers of Wood—By E. J. Salisbury. Published by Penguin Books Ltd., London, 1946. 32 pages, 24 coloured plates, Bibliography. Price 2*s.* 6*d.*

This book gives a facsimile of 24 out of 432 coloured plates reproduced from the Flora Londinensis (1777-1791) of William Curtis, bicentenary of whose birth was celebrated recently. A separate account is given of each of the common British Woodland flowers illustrated *e.g.* honeysuckle, primrose, anemone, periwinkle, pimpernel, dogs mercury etc. The commentary written are interesting and does credit to the author. In later chapters the author discusses the different kinds of trees which are to be found in British woodlands.

Curtis' original volume was not a financial success and hence Penguins deserve to be congratulated on their enterprise in publishing this book that would stimulate interest in Nature and in the art and history of colour printing. The price is within the reaches of all. Sir Edward Salisbury F.R.S., the author (Director, Royal Botanic Garden, Kew) has devoted to the study of the ecology of woodland plants and is an authority on the subject and this brochure may well be read with profit by students of ecology as well as by the lay man.

A. K. G.

LETTERS TO THE EDITOR

[*The Editors are not responsible for the views expressed in the letters.*]

SOME NEW METHODS OF DETECTING NITRATES IN PRESENCE OF NITRITE—I

ALTHOUGH a number of methods for detecting and estimating Nitrates in presence of Nitrites are known[1-3] very few give satisfactory results[4] except the Azide[5] and the Amino-sulphonic[6] acid methods. The available methods need in some cases considerably large proportion of reagents. In the case of the Amino-Sulphonic acid the reaction becomes vigorous. A simpler, and more satisfactory method is very desirable. In this communication three such methods are reported, *viz.*, (*a*) using Sodium Sulphite and dilute Hydrochloric acid and (*b*) using Sodium Sulphite, Absolute Alcohol and dilute Hydrochloric acid and (*c*) using Sodium Sulphide and Acetic acid.

(*a*) Solid Na_2SO_3 was added to a solution of a mixture of $NaNO_2$ and $NaNO_3$ acidified with HCl. The reaction proceeded with manageable vigour and can be so controlled as to avoid any NO gas being formed free. When the reaction had stopped the SO_2 gas was boiled off and a part of the solution tested for free Nitrite and Sulphite separately by KI and Starch solution and $K_2Cr_2O_7$ solution.

The Nitrite and Sulphite free solution was tested for Nitrates by Ferrous Sulphate and Conc. H_2SO_4 and by diphenylamine in conc. H_2SO_4.

(*b*) To a solution of a mixture of $NaNO_2$ and $NaNO_3$ absolute alcohol and Na_2SO_3 were added and acidified with dilute Hydrochloric acid and warmed. When the reaction was complete the presence of Nitrate was tested as in (*a*) after satisfying that there was no free Nitrite and Sulphite.

(c) Solid Na_2S was added to a solution of $NaNO_2$ and $NaNO_3$ acidified with $CH_3.COOH$ and warmed. After the complete precipitation of Sulphur, H_2S was boiled off and the filtered solution was tested for Nitrate by the usual method.

Further work on this subject is in progress

N. P. MOOKERJEA

Department of Chemistry,
Dungar College, Bikaner,
14-10-1947.

[1] *Fresenius*, pp. 482, 494-95.
[2] Scott's Standard Methods of Chemical Analysis, I, p. 631.
[3, 4] Treadwell and Hall, I, p. 420.
[5] *Ber.*, *48*, 1963.
[6] *Zeit. anorg. Chem.*, *71*, 236 and *74*, 51; *Chem. Zent.* II., 789, 1911 and I, 1250, 1912.

ACTION OF PENICILLIN AND THE SULPHONAMIDES ON *PASTEURELLA SEPTICA* AND *SALMONELLA ABORTUS (EQUI)*

VARIOUS strains of *Pasteurella* and *Salmonella* have been reported to be resistant to penicillin. The susceptibility of *Past. septica* to this antibiotic *in vitro* was observed recently[1]. Similar studies with *S. abortus* (*equi*) and *S. gallinarum* have shown the former to be more susceptible while the latter remained unaffected by 10 units of penicillin per ml. Since penicillin and the sulphonamides seem to act on bacteria in different ways, a study of their combined effect on *Past. septica* and *S. abortus* (*equi*) was undertaken. Penicillin in combination with certain sulphonamides has been found to be more inhibitory to both these organisms than either penicillin or any of the sulphonamides alone (Tables 1 and 2). Similar effect of combinations of these antibiotics on certain bacteria has been demonstrated earlier[2-6]. Sulphonamides alone, on the other hand, seemed to arrest the growth of *S. abortus* (*equi*) more effectively than of *Past. septica* when the organisms were present in small numbers only; sulphapyridine, sulphathiazole and sulphamethazine being more inhibitory.

The experimental technique followed was as described earlier.[1] The following strains were used:—*Past. septica* (52) described previously[1,7]. *S. abortus* (*equi*)-S(1), Lister Institute strain No. 766; S(125) and S(129) isolated from two aborted mares and maintained at this Institute. All these strains of *S. abortus* (*equi*) appeared to be equally susceptible to penicillin. Typical results obtained with S(125) are given. *S. gallinarum*-Lister Institute strain No. 416.

TABLE 1

*Effect of the sulphonamides and varying concentrations of penicillin on the growth of Past. septica.**

Penicillin (unit/ml)	Plain broth	Sulphapyridine 1/50,000	Sulphamethazine 1/50,000	Sulphathiazole 1/10,000	Sulphaguanidine 1/10,000	Sulphanilamide 1/10,000
0	+++++	++++	++++	++++	++++	++++
0·05	+++++	+++	++	+++	+++	+++
0·1	+++	−	−	−	−	−
0·5	−	−	−	−	−	−

* Growth or no growth is indicated by + and − signs respectively.

TABLE 2

*Effect of the sulphonamides and varying concentrations of penicillin on the growth of S. abortus (equi)**

Penicillin (Unit/ml.)	Plain broth		Sulphaguanidine 1/10,000		Sulphamethazine 1/50,000		Sulphathiazole 1/100,000		Sulphapyridine 1/100,000		Sulphanilamide 1/10,000	
	10^{-3}	10^{-5}	10^{-3}	10^{-5}	10^{-3}	10^{-5}	10^{-3}	10^{-5}	10^{-3}	10^{-5}	10^{-3}	10^{-5}
0	+++	+++	+++	+++	+++	+++	+++	++	+++	++	+++	+++
	++	++	++	++	++	+	++		++		++	++
1·0	+++	+++	++	++	++	++	+	−	+	−	+++	++
	+	+										
2·0	++	++	++	+	+	−	−	−	−	−	++	++
5·0	Trace	−	−	−	−	−	−	−	−	−	−	−
10·0	−	−	−	−	−	−	−	−	−	−	−	−

* Growth or no growth is indicated by + and − signs respectively.

One-tenth ml. of 10^{-3} dilution of *Past. septica* and the dilutions of *S. abortus (equi)* as indicated in the table, were added to 4·9 ml of the basal medium, containing plain broth alone, as inoculum. Growth was determined by the presence of turbidity after 48 hours' incubation at 37°C but occasionally subcultures were made on blood agar in the case of *Past. septica* and on plain agar in the case of *S. abortus (equi)* to detect the presence of living organisms in numbers too small to produce turbidity. The sodium salt of penicillin, containing 1620 units per mg., was freshly dissolved and diluted in sterile glass distilled water. The sulphonamide solutions were sterilized at 15 lbs. for 10 minutes.

Penicillin alone and in combination with the sulphonamides were definitely more inhibitory on smaller numbers of both *Past. septica* and *S. abortus (equi)*.

Details of this work will be published elsewhere.

Penicillin used here was supplied by Messrs. Imperial Chemical Industries.

P. R. NILAKANTAN
N. B. DAS

Indian Veterinary Research Institute,
Mukteswar-Kumaun, 28-11-1947.

[1] Das, N. B. and Rawat, J. S., SCIENCE AND CULTURE, *12*, 553, 1947.
[2] Ungar, F., *Nature*, *152*, 245, 1943.
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[4] Kirby, W. M. M., *Proc. Soc. Exp. Biol. Med.*, *57*, 149, 1944.
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NEW TELEGRAPH CODE FOR INDIAN LANGUAGES

TELEGRAPHY is primarily a method of transmitting written communication by means of electric impulses which form the code. Many types of the codes[1] have been used in different countries to suit their telegraph traffic. The Morse code which is used in America has been modified for continental use. By international agreement this continental code is being used in all radio communication, submarine telegraphy and ocean cables. All the above codes have been evolved for the Latin script which has only 26 alphabets. This international Morse code does not suit for our contidions as the alphabets in the majority of the Indian languages are far more than the Latin alphabets. The cacuminal sounds, the nasal sounds and at least 25 per cent of the Indian characters cannot at all be sent correctly by the use of the Latin alphabets in our traffic.

The new code formed by the author takes into account the occurrence of alphabets in traffic. The minimum dot time equivalents and minimum number of elements are given to the alphabet occurring maximum in our languages. A statistical survey has

अ —		आ — —
इ • •		ई • • —
उ • —		ऊ • — —
ए — • •		ऐ — • • —
ओ — • —		औ — • — —
	(•) • — • • •	
	ऍ — • • — •	
	ऑ — • — — •	
क् — — —		ख् — — — •
ग् — — •		घ् — — • •
	ङ् — • • • —	
च् • • — —		छ् • • — — •
ज् • — — —		झ् • — — — •
	ञ् • — • — —	
ट् • — • —		ठ् • — • — •
ड् — — • —		ढ् — — • — •
	ण् — • — —	
त् • • — •		थ् • • — • •
द् — • — •		ध् — • — • •
	न् — •	
प् • — — •		फ् • — — • •
ब् • • • —		भ् • • • • — •
	म् • • — • —	
	य् — — — —	
	र् • — •	
	ल् • — • •	
	व् — • • •	
	स् • • •	
	श् • • • •	
	ष् • — — • —	
	ह् •	
	क्ष् — • — • —	
	ज्ञ् — — • • —	
	ड़् • — • • —	

Table of Alphabets with Code.

been taken of the predominance of alphabets and the code is allotted in that order. To keep a definite system for training facility, the code takes into account the philological factors.[2] The long vowels are formed by the addition of a longer time equivalent *i.e.*, a dash, to the corresponding short vowels. The

short diphthong vowels are given the corresponding combinations without the addition of extra space. The aspirated consonants are formed by the addition of the aspirant to the corresponding short consonant. The two additional short vowels of the southern Indian languages are also provided for. By this system the code for 49 alphabets is reduced to only 33 for training purposes.

As combinations upto four elements are not sufficient to accommodate all the Indian characters, combinations of five elements are also used in the formation of alphabets. In these higher element combinations, the least dot time equivalents are given priority. Characters not much used in telegraph traffic are allotted higher time equivalents. This allotment reduces the frequency in cycles per second and thus at higher speeds the distortion is reduced.[3]

$$\text{f (cycles per sec.)} = \frac{\text{Nw.p.m} \times n \times t}{60 \times 2}$$

where Nw.p.m is the number of words per minute, n is the number of letters per word and t is the dot time equivalent per letter. In English as is well known an average of five letters per word is taken for telegraph traffic. For communication in Indian languages, an average of only four letters is found

Code.	Name of country.	No. of Alphabets dealt with.	Average elements per alphabets.	Average dot time equivalent per alphabet.	Freq. in cycles per sec. for the speed of 20 words per min.
Baine ..	America and Europe.	26	3·16	8·2	6·83
Navy ..	American Ships.	26	3·12	8·6	7·17
Morse ..	American Telegraph.	26	2·96	6·6	5·5
I. M. C. ..	Continent and all wireless.	26	3·15	8·2	6·83
Proposed ..	India	49	4	10·7	7·13

for words used in traffic. This average increases to 4·7 letters per word for the classical Indian words. The table compares the efficiency of the proposed code with the standard codes adopted in other countries. The average per letter in the proposed code for 49 letters is slightly greater than others because of the inevitable use of the higher elements introducing higher dot time equivalents. The lower value of the average letters per word compensates to some extent the higher dot equivalents per letter and therefore the frequency is not much increased.

The author's calculations show that the proposed code can handle the telegraph traffic by using only 83 per cent of the elements required to send the same traffic in Roman Urdu *i.e.*, using Latin alphabets and saves the operator's effort in the same porportion.

Letters and important punctuations are the same as used in I.M.C. It is seen that the proposed code can handle all the telegraph traffic in Indian languages with better efficiency and speed in addition to the vast facility.

R. D. Joshi

Radio Laboratory,
Nowrojee Wadia College,
Poona, 3-12-1947.

[1] McNicol, "American Telegraph Practice", p. 492.
[2] J. Beames, "Comparative Grammar of the Modern Aryan Languages in India", Vol. I, p. 245.
[3] J. Herman, *Bell System Tech. Jour.*, *8*, 267, 1929.

ON THE NUMBER OF POSITIVE INTEGERS $<x$ AND FREE OF PRIME DIVISORS $>x^c$

Let $f(x, c)$ denote the number of positive integer $<x$ and free of prime divisors $>x^c$. It is proved that

$$f(x, c) = x\varphi(c) + o\left(\frac{x}{\log x}\right)$$

where the 'o' is uniform for $c \geqslant$ any given positive number, and the function $\varphi(c)$ is defined by the relations:

$\varphi(c) = o$ for $c \leqslant o$; $\varphi(c) = 1$ for $c \geqslant 1$; $\varphi(c)$ is continuous for $c > o$, and $\varphi^1(c) = \frac{I}{c}\,\varphi\left(\frac{c}{I-c}\right)$ for $o < c < 1$.

The function $\varphi(c)$ has interesting properties:—

(1) $\varphi(c)$ has derivatives of all orders at every c except at $c = 1, \frac{1}{2}, \ldots \frac{I}{n}, \ldots$ (n positive integral.

(2) $\varphi(c) = o\left(\frac{c}{I\left(\frac{I}{c}\right)}\right)$ for $c > o$.

(3) $\frac{\varphi(c)}{c^n} \longrightarrow o$ as $c \longrightarrow o$ for any fixed n. (This is an obvious consequence of (2).

The results are independent of the prime number theorem. Proofs will appear elsewhere.

V. Ramaswami

Andhra University,
Waltair, 31-12-1947.

A NOTE ON THE USE OF WILSON CLOUD CHAMBER AND THE POSITIVE EXCESS OF MESOTRONS

THE importance of Wilson cloud chamber in the development of modern Physics, especially in Radio-Activity and Cosmic-Rays can hardly be exaggerated. Rutherford in-fact, described it as "the most original and wonderful instrument in scientific history."[1] For Cosmic Ray work counter controlled chambers generally used as chambers operated at random are at a disadvantage. The observation of Cosmic-Ray tracks in a Wilson chamber placed between the pole pieces of an electro-magnet led Anderson[2] to discover the position. This single act points to the importance of the use of the Wilson chamber placed in the magnetic field. Apart from the discrimination between the positively and negatively charged particles, the magnetic field has its utility in the measurement of momentum of the particle passing through the chamber.

A particle of mass M, charge Ze (e.s.u.), momentum p and moving perpendicular to the field (H) has a radius of curvature ρ given by $pc = \frac{M\beta c^2}{(1-\beta^2)^{\frac{1}{2}}} = ZeH\rho$ or expressed in electron volts $(pc)_{ev} = 300H\rho$ for $Z=1$. Knowing $H\rho$ the momentum of the particle may be directly determined. However, as the energy of the particle under consideration increases, a higher magnetic field is needed to produce any appreciable deflection. Whereas a field of 1000 guass is sufficient for energies between 10^5 - 10^7e.v. a field of 20,000 guass or more is needed for particles of 10^9 - 10^{10}e.v. This limits, therefore, the energy range to be studied by this technique. For higher energies it becomes increasingly necessary to design large electromagnets capable of producing uniform fields of this order over an appreciable volume. The cost and other technical difficulties in obtaining such high fields are known to a worker in this field. In a particular case Jones and Hughes[3] used oil cooled iron-core type magnet weighing 9100 Kg of steel and 1000 Kg of copper, working at 35-125 K.W. and producing a field of 12400-16000 guass. Such heavy equipment restricts the use of the chamber to the Laboratory, high altitude measurements being impossible. Not only that, the heating produced by the current passing through the coils of the magnet, in the vicinity of the chamber makes it difficult to keep it at a constant temperature, which is so very necessary. All these factors put limitations on the use of the Wilson chamber. To obtain all these requisites, thus increasing the usefulness of the instrument, a very simple technique, as suggested below, may be employed.

L. M. Mott Smith[4] tried to measure the positive excess of the mesons over the negatives by using the principle of magnetic deflection of particles in magnetised iron, and employing triple coincidence counter system. Two counters were used to collimate the beam of incoming particles and a third counter, the position of which could be varied, (Fig. 1) was

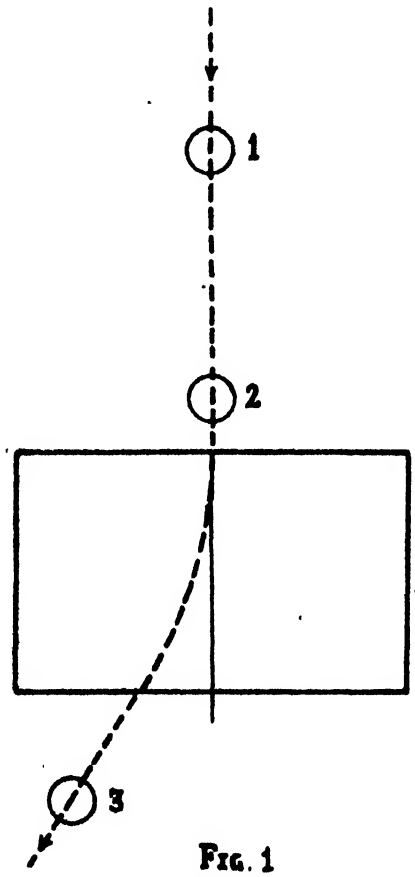

FIG. 1

placed under the iron plate magnetised perpendicular to the plane of the paper. No excess was however, found. Blackett[5] also did not find any excess of the positives. H. Jones[6] determined the positive excess of the hard component by using a Wilson chamber placed in a magnetic field. The hard component was abstracted by absorbing the soft component in 10·2 cms. of lead, (such a block should not affect hard particles with energies greater than $\cdot 2 \times 10^9$ e.v. if one assumes that they are mesons which lose energy by ionization only) the ratio of positives to negatives being about 1·29. Bernardini[7] and his co-workers have also performed similar experiments using modified technique of Smith and find an excess of about 20 per cent (I had nearly completed an apparatus, slightly different from the one used by these workers, to study the positive excess and various other phenomena connected with the mesotron but unfortunately had to discontinue due to disturbances at Lahore.)

The use of Wilson chamber and the technique employed by Smith have their relative merits and limitations. The use of both these techniques combined, as suggested, will increase the utility and the

field of application of the Wilson chamber. The necessity of a large electromagnet can be partly dispensed with by using a magnetised soft iron plate (the necessary magnetisation may be produced by a field of about 100-200 guass by Helmholtz coils or a suitable solenoid) of suitable dimensions inside the chamber, (a usual triple coincidence counter system being employed to control its working) the magnetisation being vertical to the plane of the paper (Fig. 2). This technique is especially advantageous

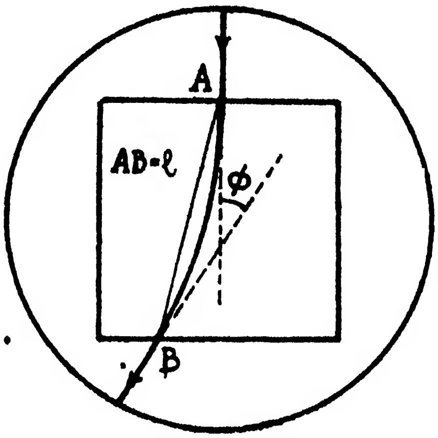

Fig. 2

in extending the limit of the energy spectrum as very high and uniform magnetic fields can be obtained inside iron, particularly in Permalloy, where it can be much higher than the highest value of the field employed so far. It will also eliminate the difficulties connected with maintainance of constant temperature in the Wilson chamber. The field inside iron (B) and the radius of curvature of the track may be easily determined. From the figure it is clear that the visible portions of the track give us the direction of the tangents to the actual path inside the plate and measuring the angle ϕ (radius) and the distance AB = 1, the radius of curvature ρ is given by $\rho = e/\sin\phi$. The whole equipment being lighter and easier to set up may be used for the study of the positive excess of the mesons and other allied problems, say its variation with altitude which is bound to yield much valuable information about the various processes connected with the mesons. With suitable modifications it may be used for the study of cosmic-ray showers and the exact determination of the mass of the meson for which the experimental values vary from 184-370 times the mass of the electron. The work on these lines is in progress and the exact experimental set up will be given later.

I wish to thank Dr P. K. Kichlu and Dr H. R. Sarma for their general interest and Dr R. C. Majumdar and Dr P. L. Kapur for helpful discussions.

Om Parkash

Physics Department,
East Punjab University,
University Buildings, Delhi.
5-2-1948.

[1] N. N. Dasgupta and S. K. Ghosh, *Rev. Mod. Phys.*, **18**, 225, 1946.
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ON REFRACTIVE INDEX OF REFLECTION

The intrinsic similarity between reflection and refraction should make it possible for the former to be viewed as a special case of the latter. Thus as a first step towards unifying the two under a single scheme, reflection since it involves turning back of the secondary waves at the surface of separation, may be thought of as being associated with refractive index $\mu = -1$. This would automatically ensure equality of the angles of incidence and reflection as generally understood. As an interesting application and confirmation of this, one may substitute this value of $\mu (= -1)$ in the formula for refraction at curved surfaces namely $\frac{\mu}{v} - \frac{1}{u} = \frac{\mu - 1}{r}$, when the formula for reflection at curved surface namely $\frac{1}{v} + \frac{1}{u} = \frac{2}{r}$ follows, where v, u are respectively the distance of the image and object from the refracting surfaces and r the radius of curvature of the reflecting or refracting surface.

The above point though somewhat obvious does not occur in any of the text books known to the author and has been submitted in view of its probable usefulness to the teaching profession.

B. Mukhopadhyay

Lac Research Institute,
Namkum, Ranchi.
8-3-1948.

CONSTITUTION OF ALKALI HALIDE—BORATE GLASSES

H. Cole[1] observes that in the halide-boric oxide glass systems a crystalline phase of the halide occurs when it exists in excess of the proportion given by NaCl, $3B_2O_3$ in the case of NaCl.

Cole has evidently made microscopic studies of the glass systems and as such his observations are complimentary to ours[2] that he refers to. The sizes of the crystallites which are discernible by the microscope are certainly much larger than the limits that can be approached by X-rays. So what Cole's results indicate is that the particle sizes of the crystalline NaCl phase are submicroscopic so long as the percentage of NaCl is below 22 per cent.

The results of experimental work carried out on such systems by two of us[3] have shown definitely that the glass formed by dissoving NaCl in B_2O_3 up to a concentration less than 21·91 definitely yield diffraction lines of NaCl. Even with a proportion of NaCl as low as 10 per cent very characteristic diffraction lines due to NaCl have been found in the X-ray photographs.

Experiments with $Na_2O—B_2O_3$ glasses by Warren and his co-workers have only revealed diffuse bands and the positions of the bands differ but little with different alkali oxide contents from the radial distributions of intensity. Warren[4] arrived at an atomic arrangement for the glass in which the oxygen of Na_2O is incorporated into the scheme as an essential constituent. In $NaCl—B_2O_3$ system this extra oxygen is absent. If NaCl takes part in the random structural arrangement which is very difficult to conceive for a polar substance there must be a new structural unit different from that of the $Na_2O—B_2O_3$ system. Our experimental results are quite contrary to such picture.

It may be mentioned in this connection that sharp diffraction lines are also obtained with Au—B_2O_3 and Pt—B_2O_3 glasses[5] in which a crystalline phase for the metallic constituent is apparent even at very low percentage of noble metals. Rooksby[6] has also demonstrated the existence of crystallites of gold and copper in gold ruby and copper ruby glass respectively.

S. K. Majumdar
B. K. Banerjee
K. Banerjee

Indian Association for the Cultivation of Science,
210, Bow Bazar Street,
Calcutta, 15-3-1948.

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A NEW METHOD FOR THE COLORIMETRIC ESTIMATION OF TRACES OF URANIUM

The estimation of trace quantities of uranium by chemical methods is of fundamental interest to the geochemist in his determination of the age of minerals by the "Lead-uranium ratio" method. Various methods for the colorimetric estimation of traces of uranium have been suggested from time to time of which the per-uranic acid method of O. Hackl[1] using hydrogen peroxide in the presence of alkali carbonates is the most simple to work but this method fails when the percentage of uranium is less than ·01 per cent. Of the other methods the ferrocyanide method was claimed to be very sensitive by J. Tschernichow and Guldina[2] but Sandall[3] has criticised this method. In the present investigation the author attempted to devise an accurate method for the estimation of traces of uranium. It was found that in the absence of interfering ions and soluble carbonates UO_2^{++} gives a blue coloured lake with an alcoholic solution of quinalizarine at a *p*H of approximately 7·2. The region of maximum absorption was determined from the plot of the percentage transmittancy with filters of varying wave lengths in a photo-electric colorimeter. The maximum absorption was always found in the region of 575 mμ. At this *p*H (7·2) the blank also gives a light violet colour. The region of maximum absorption for the blank was similarly found to be at 515 mμ. From the transmittancy curves of the two (namely blank and the uranium lake) it was found that the filter 620 mμ was the most suitable for, at this region, while the absorption of the blank was quite negligible, that of uranium lake was very near to the maximum. The percentage transmittancies of a series of standard uranium solutions of varying strengths with quinalizarine were determined in a photo-electric colorimeter using a 620 mμ filter. The plot of the log transmittancy against concentration was found to be a straight

Parts per million.	Parts per million.
U Taken	*U Found*
3·5	3·55
4·5	4·6
4·9	5·05
5·5	5·5
5·75	5·9
6·5	6·65
7·5	7·4
8·5	8·625
8·75	8·8
9·5	9·55

line when the concentration was within the range of 3 to 10 parts of uranium per million. (3γ to 10γ of uranium per c.c.). Thus Beer's Law holds good within this region and this method can be used for the colori-

metric estimation of uranium. The strength of several unknown samples were determined from the standard curve by this method. The results are given in the table. The accuracy of this method was found to be ± 3 per cent.

Further work is in progress and full paper will be published later on.

The author wishes to thank Prof. P. B. Sarkar, for his kind interest in this work and the laboratory facilities.

AMAR NATH MAJUMDAR

Laboratory of the Ghose Professor of Chemistry,
University College of Science and Technology,
Calcutta, 6-4-1948.

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X-RAY STUDY OF CRYSTALLIZATION OF AMORPHOUS SILICA

IT has been found by the X-ray diffraction method that the mean band spacing of amorphous silica gradually increases with the period of heating of the sample at high temperatures, *e.g.*, 650°C and finally sharp rings appear, showing complete crystallization. The most intense ring corresponds approximately with the position of the amorphous band. Such line-band correspondence has been found with other substances and give a support to the crystallite theory of the amorphous state. Randall and Rooksby[1] with amorphous Carbon and K. Das Gupta[2] with amorphous Selenium got similar variation of mean band spacing with the growth of the size of the crystals.

The following is the table of the mean band spacing of Silica heated at 550°C for 48 hours, photographs being taken at intervals of every 12 hours.

Hours of heating at 550°C	Plate no.	Band diameter in cms.	Θ	d × 10⁻⁸ cms.
0	1	1·637	11°1′	4·004
12	2	1·557	10°29′	4·225
24	3	1·533	10°22′	4·272
36	4	1·530	10°18′	4·298

Both Randall and Das Gupta worked with homopolar substances and got gradual decrease in the lattice constant with the growth of the crystal size. But in the case of SiO_2, from the table we see that the lattice constant is increasing with the growth of the crystal size. This is because SiO_2 is an ionic crystal. The problem has been investigated theoretically by J. E. Lenard-Jones[3] who gives reasons for anticipating such results.

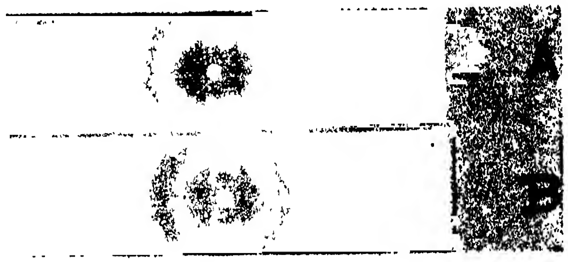

FIG. 1.
A—Amorphous Silica Gel.
B—Silica Gel heated at 550°C for 24 hours.

The increase in the lattice constant after 48 hours of heating at 550°C is found to be 7·4 per cent. It has been shown by Lenard-Jones that for a small crystal of 500 atoms deep, spacing d* is 5 per cent greater than the normal value and for 5 layers deep the percentage change would be 7, and for 3 atoms deep the change would be 14 per cent (d*>d). In the case of ionic crystal however Lenard-Jones gives the following results for Sodium Chloride.[4]

Distance between neighbouring Na and Cl. atoms :

Solid	2·81 (Observed)
Single 100 plane	2·69 (Calculated)
Single molecule isolated ..	2·30 (Calculated)

It was observed that the weight of the amorphous silica remains unchanged due to heating *i.e.*, there is no dehydration due to the prolonged heating and the change in the band spacing need not be attributed to the degree of dehydration of the sample.

In conclusion the author expresses his sincere thanks to Prof. S. N. Bose for the keen interest he has taken during the progress of the work and to Sri K. Das Gupta for helpful discussion.

S. B. BHATTACHARJEE

Khaira Laboratory of Physics,
University College of Science & Technology,
Calcutta, 7-4-1948.

[1] Randall and Rooksby, *Nature*, *129*, 1932.
[2] K. Das Gupta, *Ind. Jour. Phys.*, 389, 1941.
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PREFERENCE TESTS OF SCHOOL CHILDREN FOR DIFFERENT SUBJECTS

The writer has tested 3000 school children of 20 different institutions in Bengal and in some parts of Bihar, of which 2000 are girls and 1000 boys. Age varies from six to seventeen years. Psychological principles are followed in preparing the preference tests. Three different tests are applied to each child to find out his interest regarding different school subjects he learns in his respective class. The data are calculated statistically from two points of view, (*i*) age and (*ii*) class. In this paper the writer has based her work on class-grouping. The five compulsory subjects namely English, Bengali, Arithmetic, History and Geography are taken into consideration.

From the preference in the figs. 1 and 2 it is observed that English which has maximum number of preferences in the early ages of both the sexes decreases after sometime, and Bengali which occupies a third position in the beginning merges at the decreasing point of English and after that comes on a higher level and finally occupies the topmost position. The interest line of history comes more or less after literature. Arithmetic starts from the second level of preference in the early stage of both the sexes but gradually declines at the bottom in case of girls and to the fourth level in case of boys. The interest line for Geography is very smooth and is always at the bottom from the beginning to end in both the sexes.

Thus analyzing the data it seems that preference can be graded as English, Bengali, History, Arithmetic and Geography.

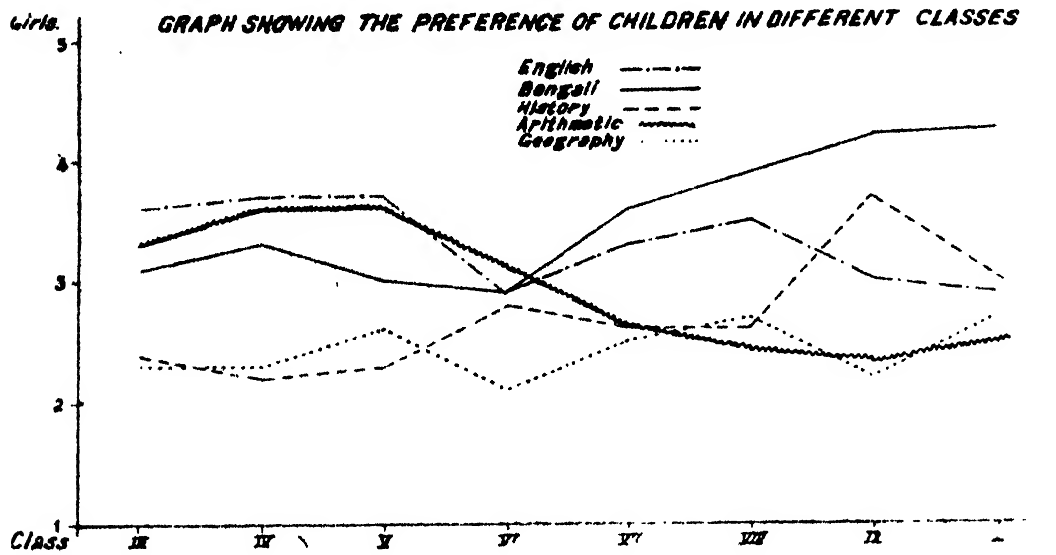

FIG. 1.

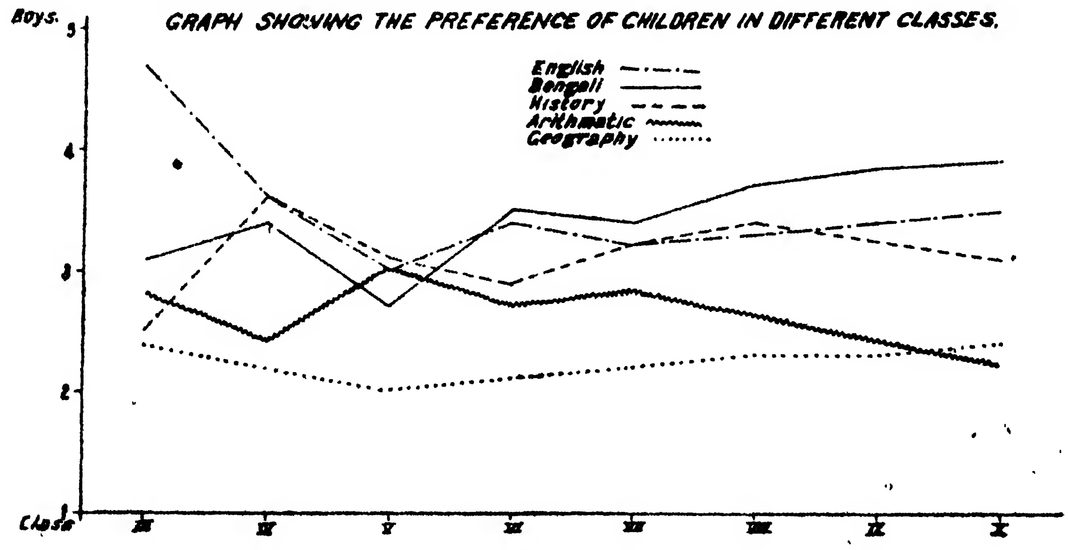

FIG. 2.

The writer is grateful to Prof. G. S. Bose for his valuable suggestions.

(Sreejukta) SHANTA DEB

Department of Psychology,
Calcutta University,
4-3-1948.

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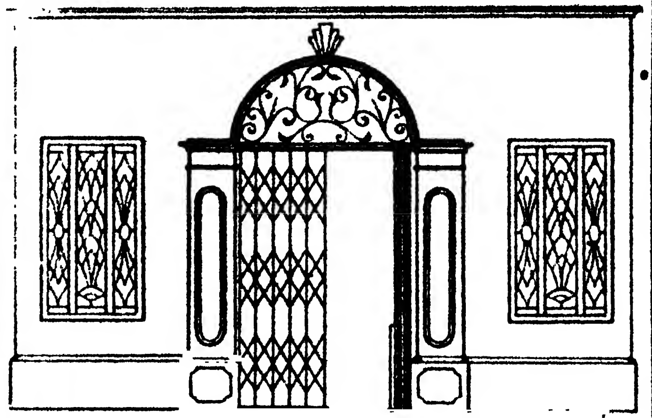

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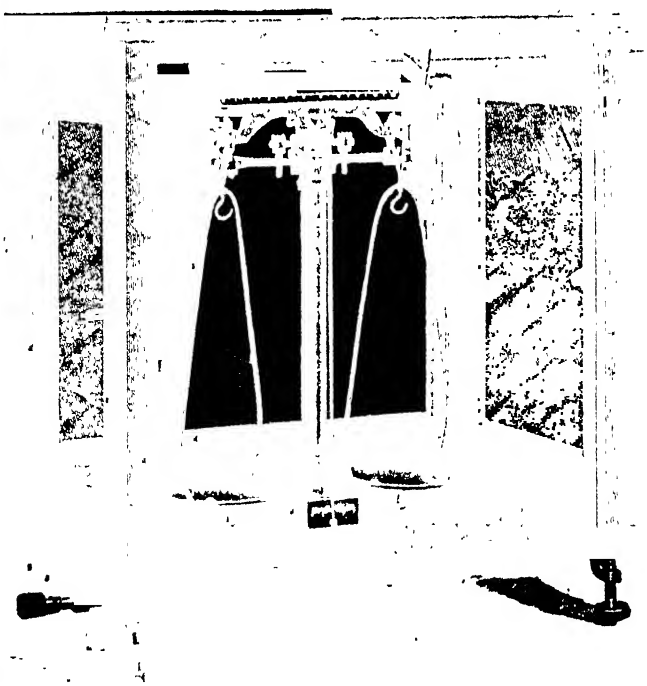

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Vol. 13, No 12] [JUNE, 1948

CONTENTS

SCIENCE AND CULTURE

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PROBLEMS OF INDEPENDENT INDIA (2)

ATTAINMENT of Independence on the part of a great country like India after long years of colonial rule has to be followed by revolutionary changes in outlook towards the totality of country's problems, inclusive of political, economic, social and religious ones. Unless the ideas are sound, and followed by prompt action, even such a great event as Independence may be followed by a period sterile in achievement, and sowing more seeds of trouble for the future.

It is our impression that though the present government is composed largely, though unfortunately not wholly, of persons who have earned undying fame as fighters for the cause of freedom, and have shown great initiative of action in certain directions, there are other equally important subjects which have escaped their vigilance and penetration. One of the most urgent set of problems to which they have so far paid only scanty attention is the *"Reform of the Administrative Machinery."* They have inherited the present machinery from the British who developed it out of their ideas of Imperialism, guided by the central thought that India was to remain for ever a part of the British colonial empire. Whatever may have been the merits of the 'steel frame' from the British point of view, our leaders who are now in saddle, were outspoken before they took office, in their criticism that the system was not suited to the needs of a free and independent country, which would want to undo the legacy of poverty and unusually low standard of living by rapid industrialization, rapid improvements in agriculture, communication and defence. But so far no effective steps have been taken, either to reorient the existing civil service personnel to the changing needs of the country, or to lay the foundation of a new civil service suited to the needs of an independent country nor to do away with the irksome procedures causing extreme delay in taking decisions. To use a metaphor we have replaced the coachman by the motor driver, but the horse has not been replaced by the motor engine.

Let us see what are the defects of the present system of administrative machinery and how a better system, suited to present day needs can be evolved. The spearhead of the present system of administration is the "Indian Civil Service" which is followed by such specialized services as provincial civil services, audit and account service, engineering, police, railway, etc. The Indian Civil Service has now been replaced by a general 'Administrative Service'. Most of the entrants to these services, except with provincial ones, are recruited on the basis of all-India competitions, from amongst the university graduates of India, and are assigned to specialized posts or to general administrative posts.

It is a continuation of the same old system of recruitment of the civil service, and their absorption in the duties of the State. No arrangement has yet been made to broaden the basis of recruitment to suit the new needs of the State, or to train up the recruits to specialized jobs, instead of allowing them to become jacks-of-all-trades.

This would have been quite right in the nineteenth century, when the peacetime activities of the State were confined only to law, order and raising of taxes and the emphasis which was laid on classical education as the most qualifying achievement on the part of the competing student had probably some justification. But with the growth of industrialism, the activities of the Government have grown to be enormously more complex. Probably public health was the first item to be added to the cares of the State, in addition to the classical items, of law and order, and at different times, public education, factory labour, transport and communication services, agriculture, fuel and power, control of internal and external trade, housing, social insurance and organization of research for industrial, agricultural and

defence purposes have been added to the cares of the State.

Though each of these subjects in a democratic society has been under a popular minister, or of officers enjoying the confidence of the head of the State, the proper care of each subject requires a body of public servants whose education and training should be vastly different and variegated from what was necessary for the police State of the nineteenth century.

How have these needs been met in other countries? Even in England where the civil servant, after recruitment by means of competitive examination is assigned to specialized jobs, and is not as a rule allowed to be jack-of-all-trades as in this country, he has not been found to be coming up to the changing needs of the State. To quote Sir M. Sadler:

> "Administrative officials seem weak in the field of imaginative and creative suggestion--in the points which characterise original minds. If you read an official file, you will find as a rule that the experienced official is better at telling a subordinate what *not* to do than at interesting him in ways of doing better what is already passably well done, or in encouraging him to conceive bold innovations in existing methods of administration."

Nor is Sir Michael Sadler alone in the severe view he has taken of the civil servants. This overdevotion of civil servants to precedent, lack of initiative and imagination, procrastination, and unwillingness to take responsibility, or to give decisions have been enumerated as lately as in 1944 in the report of the U. K. Committee on Training of Civil Servants.

The Rowland Committee (Bengal Administration Enquiry Committee, 1944-45), remarking on the habit of government organizations to be resistant to evolutionary changes, and to lag behind progress in political ideas and advances in administrative techniques, offers the following comment.

> "The main reason, perhaps, is that bureaucracies are free from the compulsion under which business organizations labour of keeping up with competitors and they do not have a profit and loss account at the end of each year to indicate whether or not their methods and their administration require amendment or improvement. The spirit of adventure and enterprise is lacking, partly because, at any rate in a Democracy, all the actions of Government servants are liable to criticism by the Legislature. They, therefore, tend to play for safety, to go slow and to rely on precedent, and to seek in the past rules for guidance and action even when the situation facing them is in essence different from the circumstances of the past to which they appeal."

Though it is the minister who is responsible for enunciating the policy of the organization under his charge, it is the traditional duty of the civil servants while decisions are being formulated to make available to the minister all information and references from facts demanding all the wisdom and all the detachment he can command. But has this job been satisfactorily discharged by the civil servant? The impression is that the civil servant "plays for safety", says Herman Finer:

> "We are beginning to see, in fact, that it is difficult for any one but an expert fairly and effectively to criticize an expert."

Though it has been admitted that guidance from experts, be he a scientist, engineer, medical man, educationist, industrial manager, or financier—are needed now for every matter of governmental policy and administration, it has not been found easy to secure this guidance. For in every country, the administrative civil service has up till now occupied all positions of vantage, and administrative authority. He usually resents it as an encroachment on his privilege, that any distinguished man from outside, should be called to such posts. H. G. Wells with a great amount of justification characterised the I. C. S. as constituting a new Brahmin caste. When expert advice is needed, the usual method is to appoint Committees of specialists whose decisions and deliberations are conveyed to the minister by the civil servant in charge of the subject, who is generally without any expert knowledge of the subject. The *expert*, even when a full time servant, is kept in an outer ring, to whom full knowledge of policy making does not reach. One such expert on public health Sir Arthur Newsholme complained before the Tomlin Commission:

> "I had no real difficulty in consulting the secretary (a civil servant), and the president (a minister) when I desired this: *the difficulty was to know beforehand when important public health matters—sometimes they arose out of my own minutes—were under discussion between the president and the secretary, and thus to secure a voice in the discussion before decision.*"

In the United Kingdom, it was the contention of the specialists that their advice had too often to be presented through administrators and is distorted in the process. As a matter of fact, the Institution of Professional Civil Servants (those not belonging to administrative services) represented to the Tomlin Commission that no decision involving technical questions should be taken unless the specialist concerned had the opportunity of presenting his advice directly to the official, or the minister taking the decision.

Though this was agreed to by the Commission the demand that the heads of technical divisions should be given equality of status with the administrative head of the department was not agreed to in 1936. Customs die hard.

But in the meantime, the World War II came and revealed, as no amount of argument could have done, the folly of keeping the professional man in the outhouse, like the poor relations of a rich man. Large numbers of scientists, technicians and other professional men had to be pressed hurriedly into

government service, and they had to be given rank and status in the administration which encroached mercilessly on the 'preserves' of the administrative civil servant. Some of the scientific men were taken as ministers others were given secretarial ranks. The absorption of scientists into the government were found so profitable that the Government of U. K appointed a Committee under Sir Alan Barlow of the Treasury, which emphasized the need of a scientific civil service in the following words (1945) :—

"The Government has decided that the scientific civil service is to be reorganized. They are deeply conscious of the contribution made by science towards the winning of the war, a contribution which may have altered the whole course of the war and has certainly shortened its duration. They are equally conscious of the contribution which science can make during peace to the efficiency of production, to higher standards of living, to improved health, and to the means of defence. They are resolved that the conditions of service for scientists working for the government shall be such as to attract into the civil service scientifically qualified men and women of high calibre, and to enable them after entry to make the best use of their abilities, in order that scientists in the government service may play their full part in the development of the nation's resources and the promotion of the nation's well being."

Measures taken to give practical effect to these views can be now briefly enumerated :

(1) Common grades with improved pay, more commensurate with the standards of administrative grade both at the time of recruitment and in ultimate prospects, have been introduced for the scientific civil service.

(2) An inter-departmental panel, consisting of the heads of scientific branches, and also of members nominated by their respective departments, have been organized, and charged with the responsibility for keeping under review the well-being and efficiency of the government scientific service, and for making proposals for any changes in the organization and conditions of service which would promote the well-being or increase the efficiency of the service.

This panel considers promotions and transfers and ensures uniformity of standards, and takes steps for improving administrative liaison between departments.

(3) Scientific workers in government service are encouraged to publish work of their own and to discuss their work with persons outside the service engaged on similar problems.

(4) For preventing the isolationist tendency of government service, measures are recommended for developing contacts with universities, and industries, for temporary interchanges of staff with these bodies, and members of scientific civil service are given a sabbatical year for work at a university or other institutions at home, or abroad at the expense of the department.

In order that pension arrangements may not constitute a barrier to interchange of staff, all officers in the permanent staff of the government are brought under the Federated super-annuation scheme of the government.

(5) The salaries of the most highly qualified members of the scientific service are brought into relationship with those of the administrative class, and gaps are narrowed down.

(6) Recommendation has been made to make most frequent transfer of suitable scientists to the Administrative class, thus making it possible for the scientific men to rise to the highest administrative post in the department *viz.*, that of the secretary.

Most of our Indian institutions including the civil service have been modelled on those of Britain, and require a thorough overhauling. India needs, more than Britain, the services of scientists and technicians for solving her economic and social problems. The voice of the experienced scientist should therefore find place in the highest levels of policy-making and administration. As recently opinions have been expressed at the highest quarters that scientists should not be allowed to be brought into administration, we think it to be our duty in pointing out the fatal error which would be committed, if such policy were to be adopted, for we would then relapse to the nineteenth century Police State.

LETTER FROM LONDON

The following is an extract of a note from the U. S. Embassy in London :

Scientists, industrialists, and labour leaders have manifested considerable interest in the formation of a Committee on Industrial Productivity, announced by the Lord President of the Council, Mr Herbert Morrison, in the House of Commons on December 18, 1947. The New Committee, which is ultimately responsible to Mr Morrison, is for this reason put on the same level as the Advisory Council on Scientific Policy and the Defence Research Policy Committee. The earlier organizations are concerned with the development of new knowledge, but the establishment of the new Committee signified that the present government is equally concerned about the prompt and widespread application of science and technology.

Sir Henry Tizard, who acts as chairman of the earlier organizations, will also be the chairman of the Committee on Industrial Productivity. The person responsible for policy with regard to the development of new knowledge will also be charged with recommending means for its most efficient use. This fact

alone warrants the closest attention being paid to the future accomplishments of the new Committee.

The concern of the Committee on Industrial Productivity will, as its name suggests, be primarily in the application of existing scientific and technological knowledge to industry, agriculture, and health. The social and psychological factors which accelerate or impede the introduction of new scientific knowledge are also to be studied in the light of current and future knowledge in the social sciences about this subject. Stated formally, the terms of reference of the Committee are:

"To advise the Lord President of the Council and the Chancellor of the Exchequer on the form and scale of research effort in the natural and social sciences, which will best assist an early increase in industrial productivity, and further to advise on the manner in which the results of such research can best be applied."

The extremely wide frame of reference of the Committee, comprehending as it does, an examination of all factors which assist in an increase of national productivity, is somewhat narrowed when attention is paid to the panels which are to be established by the Committee.

One panel, under the chairmanship of Sir William Stanier, F.R.S., will be concerned with technological and operational research. Operational research, as used in Great Britain, has come to mean an attempt to provide executive or administrative officers with a quantitative estimate of their operational variables by use of the scientific method.

A second panel, under the chairmanship of S. Zuckerman, C.B., F.R.S., professor of anatomy at Birmingham, will deal with the question of import substitution. This group will presumably develop their work in the light of the current international shortages in hard currency and undertake to suggest better means of using local and colonial raw materials and substitutes for traditional British imports. It is of some importance that both scientists and economists are represented on the panel.

A third panel, under the chairmanship of Sir George Schuster, K.C.S.I., K.C.M.G., C.B.E., M.E., will deal with the human factor affecting industrial productivity. This group will presumably investigate the causes of dissatisfaction among workers, the prospect for increasing individual output, the views of the worker and his organization on the introduction of the new technical developments.

Finally, Dr Alexander King, director of the Scientific Secretariat of the Lord President's Office, will head a panel on technical information service. This group will recommend means for the more rapid dissemination of scientific knowledge with a view to its introduction into industry, agriculture, and other phases of the nation's production.

The Committee will operate in close co-operation with the Advisory Council on Scientific Policy because of Sir Henry Tizard's connection with both bodies. The Committee, as currently constituted, will be made up of representatives from government and university science, government departments, industry, and labour.

Science 107, March 19, 1948.

COAL RESEARCH FOR THE PRODUCTION OF METALLURGICAL COKE

S. N. SIRCAR
THE TATA IRON & STEEL CO. LTD., JAMSHEDPUR

SMELTING of iron from iron ores by huge blast furnaces has always been possible with the help of suitable coke produced from good quality caking coals. The enormous development of the iron and steel industry of today has been responsible for fast depletion of limited reserves of good quality caking coals everywhere including India. Attention has therefore been directed to this serious problem of coking coal reserves and the metallurgists all over the world are emphasizing the need of conserving this particular type of coal. Measures have been taken to restrict its use only for metallurgical purposes and to blend with inferior grade poorly coking coal with a view to prolong the period of its availability for metallurgical purposes. These measures will not however safeguard the metallurgical industry for eternity and unless fresh deposits of coking coals are discovered and a fundamental change is brought about in the process of iron smelting the very existence of the metallurgical industry is threatened. Alternatively the possibility of converting the non-caking coals, the reserves of which are almost unlimited, into coking coal should be explored.

In a country like India, where the coal reserves specially of good coking coal are very limited, the importance of the development of such a process can-

not but be too strongly emphasized. Sir Cyril S. Fox, (a former Director, Geological Survey of India) stated that the reserves of coking coal of metallurgical qualities in India are sufficient to last only for another 60 years at the present rate of consumption. This is not a period for a basic industry on which the civilization and industrial development of a country depends. With the contemplated gradual expansion of the steel industry in India this period will be further reduced. India has vast resources of best quality of iron ore. The iron ore deposits in India are estimated to amount to 10,000 million tons. To obtain pig iron from these by methods at present in vogue about 10,000 million tons of coking coal is indispensable if our iron and steel industry has to thrive. Against this our total resources of good coking coal is estimated to be 700/800 million tons according to the "Report of the Indian Coalfields' Committee, 1946". Thus the situation our iron and steel industry has to face in the future is rather grave.

Experiments and researches to explore the possibilities of converting non-caking coals into coking coals have been carried out to an appreciable extent in other steel producing countries in the world but still the problem of why certain coal have the ability to form a hard coke on heating while others of very similar type have not, remains unsolved. India will have to take a lead and utilize the best available talents in the country for extensive and intensive research on this line with a view to safeguard the future of the Iron and Steel Industry.

A brief review of the work that has been done so far in this direction in different countries and suggestions for researches in India in this connection are given in this paper.

Besides the fundamental research work done on the caking property of coal, a considerable amount of work has been done to produce coke from non-coking coals by various means.

Numerous attempts have been made in the laboratory to prepare from cellulose, wood and other vegetable matter, products which have the characteristics of bituminous coal. The usual method employed has been to heat the organic matter under pressure either alone or with some chemical reagent; and it has been claimed that the black vitreous product obtained is identical in chemical characteristics with bituminous coal. Bergius heated cellulose and also peat in an autoclave with water to temperatures of 250°, 310° and 340°C and concluded that the products were similar in character to coking coals and that these laboratory experiments indicated the manner in which bituminous coals were formed in nature.

Fischer experimented on the carbonization of coal at pressures of about 50 atmos. He finds that strong dense cokes can be obtained from that we usually described as non-caking coals of high oxygen content. The increase in pressure hinders the distillation of tar which is then more exposed to thermal decomposition, giving a carbon residue which acts as the binding agent for the coke. The necessary pressure is obtained without mechanical help by restricting the escape of the coal gas. Similar experiments have also been done by Blayded, Noble and Riley and the micro strength of the coke made under a pressure of 20·4 lb. per sq. inch was comparable with that of an average metallurgical coke.

The agglutinating properties of pitch is well known as evidenced by its use in the manufacture of carbon electrodes and in the briquetting of non-caking coal dust. L.J. Davis has described the production of coke from powdered anthracite by mixing it with 20 per cent of pitch or 25 per cent of tar, or with a mixture of the two, before carbonization.

F. Fisher produced a good coke from non-caking coal by addition of ordinary or oxidized low temperature tar with 1 : 1 mixture. Oxidation of the low temperature tar by passing heated air which increased the viscosity of the tar, rendered it more suitable for mixing with the non-caking coal to get good coke.

When the Bergius process of hydrogenation of coal by hydrogen under pressure became known it opened up further line of research on coking properties of coal. Hydrogen was made to react with non-caking coal under pressure and a temperature of 370°C. giving a solid product which had a caking power even beyond the range of normal coals. The principal effect of hydrogen was to remove oxygen as water, with a consequent increase in the benzene extraction, which according to Bone, is the constituent responsible for the caking property of coal.

In the field of coal research, therefore, the amount of academic work done, has been considerable but such tests have not yet been developed to a point of practical usefulness. Commercial applications of the experimental test results are scarce and the results of some of the commercial units installed are yet to be proved. One of this commercial applications is known as the National Fuel Process for Coal Carbonization developed by the Cyanamid Company of America. The process provides an economical means of producing a good quality coke from semi-bituminuous or bituminuous coals, having even a slight coking property by the addition of tar.

In this process the coal unloaded from tar is ground to 30 mesh or finer size and dried to less than 2 per cent moisture. The coal is then fed to a receptacle called 'fluxer' where it is mixed with tar-acid binder. From there it goes to the briquetting press, and then to a cooling conveyer to harden the briquettes. The briquettes are fed continually into

the top of a vertical cylindrical retort and descend by gravity counter current to an ascending stream of heated gas which produces carbonization. The carbonized briquettes produced are of a dense character weighing about 42/47 lbs./cu. ft. and have a sp. gr. of about 1·25.

One such plant of 100 tons per day capacity is about to be installed at one of the large steel plants in America to produce coke for blast furnaces from non-caking coals.

In England, Strafford developed the 'Fuelite' process to convert non-caking or weekly caking coals into a coherent coke. In this process a highly caking bituminous coal is mixed with non-caking coal in such a proportion that the excess of bitumen in the highly caking coal over the coke forming requirement is taken up by the lean coal, so that the whole mixture may form a coherent coke. To permit very intensive mixing the caking coal is slaked with water, creosote or similar liquids easily emulsifying into iron boxes, the dimensions of which correspond to those of the retorts into which the boxes are transferred to carbonize their contents. Depending upon the conditions applied, a foundry coke, a metallurgical or a domestic coke may be manufactured by this process.

L. Weber developed briquetting and carbonizing process to convert non-caking coals into shaped hard coke in which in place of coal tar pitch he used sulphite lye as a binder. This was followed by the two-step process especially applied to lignite, by which the lignite is first subjected to low temperature carbonization and the semi-coke produced is then crushed and briquetted. In the second stage the briquettes are hardened by carbonization.

The two-step process was also applied to coal. The first process of this kind, which was operated on a large scale in America is called the 'Carbocoal' process. In this process, the non-caking coal is first crushed and subjected to low temp. carbonization in horizontal retorts. The semi-coke produced is crushed and mixed with pitch obtained from the distillation of the low temp. tar. The mixture is then briquetted and subsequently carbonized in inclined chamber ovens at high temperatures.

Swichoslawski and Charozy also made experiments and produced a coherent metallurgical coke from non-caking coal, by mixing the coal with 4/10% of pitch, briquetting at 250 lbs./sq. inch and subsequently carbonizing. A similar process was also developed by Dalkes Kemp under the name of 'Colloidal Briquetting'.

Most of the processes described above have been carried on a small scale just to prove their technical adaptability without their being introduced on a small scale. The two stage process of manufacturing shaped metallurgical coke from non-caking coal and lignite has however been developed on a commercial scale in Germany by Didier-Werke, A. G. Berlin. This process has been fully described by Thau in his technical paper on Metallurgical coke. The process in brief is as follows:

By this process the weakly caking or non-caking coal with high volatile contents is in the first stage transformed into semi-coke by low temperature carbonization at temp. ranging between 500/700°C.

In the second stage the semi coke is crushed and intensively mixed with about 10% of good coking coal and about 6% of coal tar pitch obtained from the low temp. carbonization process. The mixture is then heated to a temp. of 105°C. by the application of indirect steam and in this state the mixture is briquetted to the desired shape under a pressure of 100/200 atmos. The briquette thus produced are hardened by carbonization at 900/1000°C.

Suitable blast furnace coke from lignite or other geologically young non-coking fuels has been successfully produced at the Didier Werke and an actual blast furnace trial run over several days conclusively proved that metallurgical coke made by this process from lignite was in every respect a suitable blast furnace fuel.

The commercial application of the two-stage process has been perfected. Thau has made a comparative analysis of cost and economy for a 3000 tons per day capacity plant with the normal coke ovens of similar capacity. As regards economy it is stated that although the cost of producing metallurgical coke by the two stage process is higher than the cost of coke oven coke, the manufacture of coke by the two stage process is economical when its even shape, its dense structure, its high reactivity, its easily penetrable bulk as well as the considerably reduced losses by abrasion are considered. In many cases, depending upon the location, the production costs of the shaped coke will be more than compensated by the freight to be debited to the price of the coke oven coke which has to be transferred over great distances while the basic fuel enabling the production of shaped coke may be had within the vicinity of the consumer.

It will be observed from the above that considerable amount of work both of fundamental and practical nature on the coking property of coal have been done in the industrially advanced countries of the world. As far as India is concerned, the industrial awakening being very recent research work on coal has therefore been practically negligible. Very little attempt has been made so far about scientific use of coal.

Since the last two decades, because of the various reports published about the small reserves of good coking coal in the country which is threatening the

existence of the metallurgical industry, the Govt. has become conscious of the situation and various steps are being taken to the scientific use of coal for different purposes with a view to conserve the remaining reserves of coking coal in the country.

The urgency and importance of research work has also been recognized as the only sure means of providing the sound basis for the proper utilization of the country's coal resources. On the recommendation of the Coal Mining Committee, 1937, a Fuel Research Committee has been constituted since 1940 under the Council of Scientific and Industrial Research, India.

As a further step towards systematic and regular research work the Govt. of India has now set up a Fuel Research Institute at Dhanbad. This Institute will no doubt undertake many of the research work connected with coal and the work will be taken up in the order of priority of urgency and importance. The research station has now come into being for more than a year and it will take sometime yet before the station is properly equipped and staffed to undertake regular research work of any importance.

It is the shortage of coking coal in the country which is most menacing to the development of Iron and Steel Industry of India and therefore all attention should be diverted and concentrated towards the economic use of coking coal and the possibility of economic conversion of non-coking coal, of which there is large reserves, into metallurgical coke.

Coking research, should therefore be given the first priority in order to safeguard the existence of metallurgical industries in India, although work on other problems may be carried out simultaneously. The discovery of lignite deposits in the Madras Presidency opens up further field of research work on caking because if by the two stage process metallurgical coke can be produced as claimed by Thau, it will lead to the development of a steel industry in South India where rich deposits of iron ore and limestones already exist.

It is therefore highly desirable that systematic research work on semi-industrial scale should be started immediately in the country* to find out if caking properties of feebly caking or non-caking coals of India may be improved appreciably for the good of the iron and steel industry of this country. Attention of the country's Government and of the Fuel Research Institute should be drawn to this aspect of the coal problem which demands priority over other aspects of coal research.

* Work in this direction has already been undertaken by The Coal Blending and Coking Research sub-committees functioning under the Fuel Research Committee of the Council of Scientific and Industrial Research.

PRODUCTION OF MESONS IN THE LABORATORY

P. C. BHATTACHARYA*

INSTITUTE OF NUCLEAR PHYSICS, CALCUTTA UNIVERSITY

It is reported that E. Gardner and C. M. G. Lattes[1] have produced mesons in the laboratory by bombarding targets of carbon, beryllium, copper and uranium with projectiles of high energy alpha-particles obtained from the 184 inch synchro-cyclotron of E. O. Lawrence at Berkeley, California. The photographic method was used for the detection of these particles. It was observed that mesons were produced when alpha-particles of 380 mev (million electron volts) were allowed to impinge on a target of carbon. The particles which emerged out of the target were bent by the magnetic field of the same apparatus and allowed to fall on a stack of photographic plates (Ilford Nuclear Research plates, type C-2 with an emulsion thickness of 50μ). The exposure times were about 10 minutes and the alpha-particle current was about 1/10 microampere. Each plate shows about 50 meson tracks along its edge, with a quite large number of heavy-particle tracks in the same area. The latter type of tracks are attributed to stars and recoils produced by neutrons and are generally found to be present all over the plates. Figure 1 shows a typical meson track ending in a star as observed by Gardner and Lattes.

Identification of particles responsible for these tracks were made on the basis of the appearance of the tracks in the emulsion and their grain spacing. These tracks show the same type of scattering and variation of grain density as was found in the case of cosmic ray meson tracks by Lattes, Occhialini and Powell[2] in Bristol, England.

Further, these particles were confirmed to be mesons from the determination of their masses by the measurement of $H\rho$ and range. The masses of these particles were thus found to be equal to $(313\pm16)m$

* I. C. I. (India) Research Fellow.

where m is the mass of an electron. This shows that they are almost certainly the *heavy mesons* found in cosmic rays by the Bristol workers[3]. A large number of these mesons were found to end in stars *i.e.*, they produce at the end of their range nuclear disintegration with the emission of heavy charged particles. One third of the tracks were found to end in the emulsion without a decay product or a star.

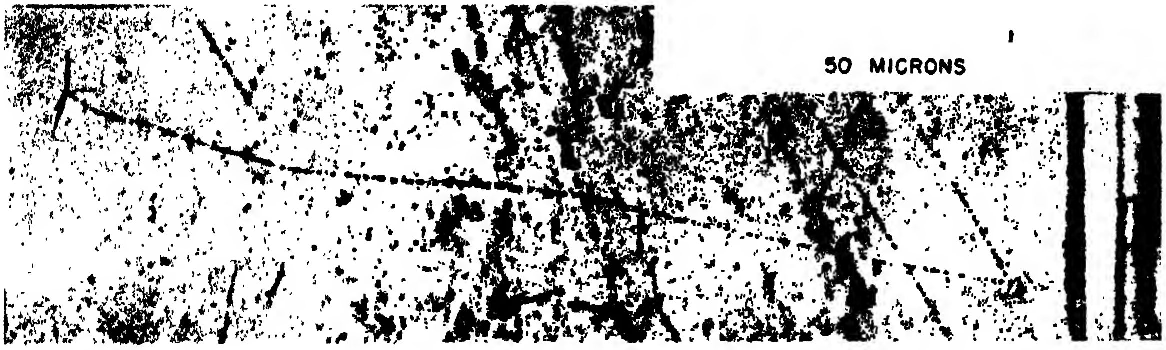

Fig. 1. Track of a negative meson produced artificially in the laboratory. It enters the edge of the photographic plate on the right, moves towards the left and produces a nuclear disintegration (star) at the end of its range. (*After* Gardner and Lattes).

Up to the present 49 tracks were measured and all of them were attributed to negative mesons. There is no significant difference between the masses of the star and no-star particles and the mean mass of all the particles is $(313 \pm 16)m$; the deviations of individual value from the mean is within the experimental error. The authors believe that in view of the large number of tracks available for measurement, it will be possible, in the near future to reduce the errors of the mass determination to the order of 2 per cent. No measurements have yet been made for the mass of the positive mesons.

With 380 mev alpha-particles the yield of mesons was considerable although there was indication of meson production even with 300 mev alpha-particles. From the point of view of meson production, an alpha-particle of energy 380 mev can be considered to be approximately equivalent to four nucleons (two protons and two neutrons) each of energy 95 mev since the binding energy is small compared to the kinetic energy of these alpha-particles. It can be seen that a 95 mev nucleon has not sufficient energy to create a particle of rest mass $300m$. But the present experiment shows that the production of mesons occur even when the kinetic energy per nucleon is about 75 mev. For this reason one may think that the production process is not due to the interaction of two nucleons but is due to a new process in which the alpha-particle interacts as a whole and its interaction with carbon gives rise to mesons.

It has been pointed out by Gardner and Lattes that it is still possible to reconcile the present observation with the view that mesons are created in the interaction between individual pairs of nucleons if proper account is taken of the internal kinetic energy of the nucleons in the colliding nucleus as was originally suggested by McMillan and Teller.[4]

Suppose that the internal kinetic energy of the nucleons, in an alpha-particle or in a carbon nucleus to be 25 mev (Fermi limit). For the production of mesons, it may be assumed that the most favourable collisions will be those in which the relative velocity of the pairs of nucleon (one from alpha-particle and the other of the carbon) has the greatest possible value. The maximum kinetic energy available in the centre of mass co-ordinate system of the pair of nucleons in such a collision will be equal to $\frac{1}{2}(\sqrt{95} + \sqrt{25} + \sqrt{25})^2 = 195$ mev. Thus a nucleon of 195 mev has sufficient energy to produce a meson of mass $320m$. The observations are thus consistent with the simple assumption that the mesons arise as a result of an interaction between single pairs of nucleons.

In this connection it may be mentioned that by using the photographic technique Occhialini, Powell[5] and their co-workers at Bristol have been able to recognize three types of mesons in the cosmic radiation and these are called π, σ and μ mesons. Of these, the π and σ mesons are heavy mesons. Their masses were determined by observing the small angle scattering which they undergo in passing through the emulsion. The masses of both these types were thus found to be $(270 \pm 40)m$. They also found that σ mesons produce nuclear disintegration (star) at the end of their range while π mesons decay with the emission of a secondary μ-meson. Figure 2 shows a typical π-meson changing into a μ-meson.

As they did not apply a magnetic field in their experiment and as the ionization does not depend on the sign of the charge of the ionizing particle, it

was not possible to determine precisely the charge of these particles. However, Occhialini *et al* inferred that the π-mesons and most of the σ-mesons are respectively positively and negatively charged particles of the same type. Further the ratio m_π/m_μ of

Fig. 2. A π-meson enters the photographic plate from the left. It moves towards the right and changes into a μ-meson which moves horizontally and finally ends in the emulsion. The π-meson was, in fact, moving vertically downwards. It was found in cosmic rays. (*After* Powell and Occhialini).

the mass of the π-meson to that of the μ-meson was determined by the method of grain counting. The result thus obtained is, $m_\pi/m_\mu = 1{\cdot}65 \pm {\cdot}15$. If it is assumed that the μ-mesons are identical with the cosmic ray mesons of mass $200m$ the above result corresponds to a value of $m_\pi = (300 \pm 30)m$. Thus the masses of the artificially produced mesons and of those of the heavier variety of cosmic ray mesons are therefore equal within experimental errors. In view of the points of similarity in their behaviour when brought to rest in the photographic emulsion it may be taken as established that the two classes of heavy mesons observed in cosmic rays at Bristol and artificially produced at Berkeley are identical.

As regards the life of π-mesons, experiments indicated that τ_π is greater than ${\cdot}4 \times 10^{-10}$ Sec. Preliminary observations show that the time of flight and hence the life of the artificially produced mesons, assuming them to originate in the target material and to proceed to the photographic plate without suffering spontaneous decay, is of the order of 10^{-9} Sec. This result is consistent with the value of $\tau_\pi < 2 \times 10^{-8}$ Secs as deduced by Marshak and Bethe[7] from the absorption curve of the penetrating component of the cosmic rays at great depths.

It is interesting to recall that from theoretical considerations Heitler and co-workers[7] postulated two types of mesons: vector mesons and pseudoscalar mesons. The first variety decay into the second type after a life of $\sim 10^{-8}$ Sec. The mesons at sea level are all pseudoscalar variety which disintegrates into electrons and neutrinos after a life of a few micro seconds.

As regards mesons in cosmic radiation it is found that they are radioactive and decay into an electron and neutrino after a short life of about two microseconds.[8] Conclusive evidence of meson decay is secured from Wilson chamber experiments of cosmic rays. Up till now there are 5 or 6 pictures each of which shows that a positive meson decay into a positron; but there is not a single picture showing the decay of negative meson into an electron. There are some instances where a negative meson has stopped in the gas of the Wilson chamber but without any decay product. Free slow negative mesons have a capture probability by atomic nuclei that is high compared to the decay probability and are therefore captured before decay. But it is difficult to conceive that a particle with energy of 10^8 ev can enter into a nucleus without effecting its complete disruption.

Evidence for the decay of negative mesons has been recently obtained by Conversi *et al*[9] and Schein *et al*[10] who measured the life of positive and negative mesons in NaF found that the decay periods are different. Rossi and Valley[11] found that in duraluminium the life of positive meson is $(2{\cdot}10 \pm {\cdot}24) \times 10^{-6}$ Sec. and that of negative ones is $({\cdot}74 \pm {\cdot}17) \times 10^{-6}$ Sec.

It is found that the mass of mesons in cosmic radiation vary within wide limits—the minimum being $100m$ found by Auger[12] and the maximum $350m$ found by Anderson and Neddermeyer[13] excluding the

case reported by Leprince-Ringuet[14] who found it to be $(990 \pm 12)m$. This large discrepancy in the masses of cosmic ray mesons which are much above the experimental errors was a puzzle to physicists for a long time. Probably these variations in masses can now be explained on the basis of π, σ and μ-mesons.

Much work will have to be done before one can correlate all these phenomena regarding mesons detected in cosmic rays with those artificially produced in the laboratory. Berkeley experiment, although preliminary in nature, promises a great future.

Now one can study the properties of mesons in the laboratory with a source of mesons which is about 10^8 times that available in cosmic rays. Undoubtedly this discovery will lead to a period of rapid advance in Nuclear Physics specially in the development of our knowledge of the internal motion of the nucleons, their interaction, and the forces between them which give stability to the nucleus. In short, it will help us to unravel the mystery hidden in the nucleus of atoms.

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ON ODOUR AND ODORANTS

O. N. PERTI,

DEPARTMENT OF CHEMISTRY, UNIVERSITY OF SAUGOR, C. P.

THE role of odour in animal life is of great importance. Most animals are known to possess distinctive odours and the sense of smell in them is very highly developed. This is of great use to them for preservation of the self and hunting. They also utilize this acute sense of smell in avoiding poisonous fruits and herbs. The habit is also found in man who frequently uses smell to discriminate food. The role of smell in nutrition is well known. The smell of appetizing food starts reflexes such as the secretion of the saliva and also the secretion of stomach juices to prepare for the digestion of the food before it is taken. Generally speaking it is the smell which in most of the animals is responsible for reproduction. It probably initiates copulation which is consummated by tactile temperature and visceral sensations. Birds are, however, an exception. Their courtship is usually based on an appeal to the eye and the ear rather than on the sense of smell.

Nature has endowed man with a sense of smell though not so acute as that of animals but powerful enough to influence his civilization. His aesthetic enjoyment derived from smelling a flower had led to the establishment of a big industry dealing with perfumes. His olfactory problems have always given a headache to the Public Health and Hygiene department. In 1875 England passed a law defining a bad smell as a public nuisance. Control of odours from sewage has led to a good deal of research which has resulted in considerable improvement in the design of the sewage system. Water for drinking should not be contaminated with any foul smell.

One of the universal rituals of man's religion is the burning of incense to various deities. Havelock Ellis has stated that during religious excitement a real and pleasant odour is discernible in the atmosphere. The evil spirits are always invariably associated with foul smell. The ancient medical man used odour for diagnosis of disease and its cure. Every chemist knows how useful is his nose in the organic and inorganic analysis.

Various odours emitted from factories require careful handling to minimise their evil effects. The arena of human foodstuffs promises a vast field for investigation and study. Many desirable edible substances cannot be consumed because of their foul smell. There is even indeed money for the man who can find an easy method of taking away the smell of onions and garlic from human breath after they have been eaten.

Human nose has often warned men of the dangerous natural gases say, those emitted in coal mines. Smell in human life is very closely associated with memory. How often a certain smell reminds

us of a remote incident. Many cases of acute distraction have been known to be caused by the smell of a woman's hair with its suggestion of closer intimacy. The art of modern perfumer has endowed certain scents with the amazing properties of allurement, captivation and seduction!

Let us turn to the attempts of the men of science to explore the mysteries of odour. The existing theories of odour can be broadly considered under two heads.

I. Those theories in which it is proposed that the odour is due to the particles of odorant moving in the air and entering nasal orifice thereby coming into contact with the olfactory region and stimulating it either by chemical or vibratory action or both.

Theories depending purely on chemical action are those of Woker[1], Marchand[2], Henning[3], Backman[4], Heller[5], Durrans[6], Tschirch[7], Delange[8], Missenden[9], Pirrone[10] and Niccolini[11], while Zwaardemaker[12] advanced the view that the stimulation of olfactory sense was due partly to vibratory and partly to chemical action. Dyson[13], however, has suggested that olfactory stimulation is due to the vibrations of molecules of odorants reaching the olfactory flagella.

II. Those theories in which the odorant is supposed to emit "waves" which excite the olfactory organ. This view is supported by the work of Ogle[14], Fabre[15], Heynix[16], Teudt[17], Ungerer and Stoddart[18], and Krisch[19].

The evidence for a purely wave theory is very meagre. It is well known that odour travels with the wind. No air borne or other vibrations have been detected so far. The nature of these waves is entirely speculative. On the other hand, a large amount of data is now available which strongly indicated that broadly speaking there appears to be a distinct relationship between certain types of chemical groupings and odour. The greatest stumbling block in the way of so called chemical theories is the fact that optical enantiomers are frequently found to give odours of different intensity. In the following Table are given some examples of such differences.

TABLE 1

Optical enantiomers of	Observation on odour
3 : 7-dimethyl octanol[20]	*d*- > *dl*-
3 : 7-dimethyl octanol[26]	*dl*- > *d*-
4 : 8-dimethyl nonanol[20]	*dl*- > *d*-
m-methyl-cyclohexyl-ethylene oxide[21] ...	active > inactive
1 : 3-dimethyl-5-cyclo hexanone[22] ...	different for *d*-, *l* and *dl*-
1 : 3-dimethyl-5-cyclo hexanol[22] ...	*d*- > *l*-
Derivatives of amino and bisamino methylene camphors[23]	*l*- > *dl*- > *d*-

Since such differences exist it is apparent that the tridimensional structure of the molecule must play a very significant role in the phenomenon of olfaction. Optical antipodes presenting different osmophore groups can be understood easily if it is postulated that monomolecular layers are taking part in the "reaction". In such a case it is clear that only one face of the tetrahedral structure of the asymmetric centre is presented for action. Of the four different groups attached to the asymmetric atom only three can be presented at one time in a monomolecular layer. These can be different even in the case of optical antipodes depending upon which surface of the tetrahedral is presented for action. In the case of *dl*- form, however, the odour to a large extent would depend upon the nature of the *dl*- form. The racemic form may be (*i*) a mixture of two optically active and opposite forms, (*ii*) a compound of these two forms or (*iii*) a solid solution of dextro- and laevo-forms due to the enantiomorphs being isomorphous. When the odour of the *dl*- form is greatest or least of the *d*-, *l*- and *dl*- forms it would indicate that the racemic form is a true compound. If, however, the odour of the *dl*- form is intermediate of *d*- and *l*- forms no definite conclusion can be drawn regarding its nature. Similar explanation can be offered to elucidate difference of odour between geometrical isomers for instance in the case of 1-*cis*-3-*trans*-dimethyl-cyclohexanone having odour like mint and 1-*cis*-3-*cis*-dimethyl-cyclohexanone having odour like cineole and thujane.[24]

It is apparent that if such a mechanism can explain the differences of odour in the case of optical and geometrical isomers it must be equally applicable to all the odoriferous organic molecules. A large amount of data is now available from which a few salient points regarding odour and odorants can be deduced.

1. A substance to be odorous must at least be so much volatile at ordinary temperature as to furnish sufficient molecules to form a monomolecular layer in the olfactory region.

2. A substance to be odorous must be soluble in the liquid material present in the region of olfaction.

3. Besides the above physical properties the molecule should contain one or more osmophore groups or else the set up of the molecule should be such as to excite vibratory motion in the fibres of the nerve endings in the olfactory region.

4. The mechanism of the action is through monomolecular layer. The actual "reaction" stimulating the olfactory sense is partly vibratory and partly chemical. The vibratory action being mainly responsible for stimulation of odour and chemical action chiefly accounting for the removal of monomolecular layer.

To sum up the idea in brief is that a substance which is volatile at ordinary temperature, soluble in liquid present in the olfactory region and possesses particular molecular set up due either to the presence of one or more osmophore groups or otherwise is odorous. The odour is due to the volatilization of the substance and air borne molecules reaching the nasal epithelium. There the molecules dissolve in the liquid present and form a monomolecular layer over a part or whole of the region of olfaction. The molecules then induce a vibratory motion in the fine olfactory hairs (flagella). These vibrations are carried by "afferent" fibres of olfactory nerve to the olfactory bulb of the brain and thereby give rise to impressions of odour. In the meantime the dissolved molecules are washed away by the liquid present in the olfactory region or they combine chemically with it and cannot influence the flagella any more. For odour to be perceived again a fresh layer of molecules is necessary. Let us now examine these ideas in a little detail.

The first point in consideration is the volatility of the substance. It has been frequently argued that if volatility at ordinary temperature is an essential prerequisite of odoriferous materials they should all show a perceptible decrease in weight after sometime when exposed to air. Contrary to this the case of a powerful odorant like musk (natural) is usually cited as not showing any appreciable decrease in weight over long periods. That the case is not anomalous may be shown as follows. The value of minimum number of molecules to be thrown off per second to give odour has been estimated by various workers (*vide*, International Critical Tables) to be in the neighbourhood of a million. If we consider musk as muscone (3-methyl-cyclopentadecanone, Mol. Wt. 238) and suppose it to volatilize at the rate of a million molecules per second then 1 gm. of the substance would completely volatilise in

$$\frac{6{\cdot}06 \times 10^{23}}{238 \times 10^{6} \times 60 \times 60 \times 24 \times 365} \text{ years or } 80{,}710{,}000 \text{ years.}$$

In other words it would take approximately 80 million years to cause a decrease of 1 gm. in weight of muscone. It is apparent that even in a hundred years the decrease in weight would be only 1/8000,00 of a gram, a negligible quantity.

Next we turn to solubility. If molecules are to excite the vibratory olfactory flagella which are embedded in the liquid (mucus) present in the region of olfaction they must reach them. And further, to explain the phenomenon of evanescence it is necessary to postulate some means of removing the substance quickly from contact with the fine olfactory flagella. The easiest is to suppose that the molecules dissolve in the liquid present in the region of olfaction and are washed away from active contact. On the other hand if we suppose that it is chemical action which removes odoriferous molecules it is difficult to understand how this conception can explain the case of paraffins which are practically inert chemically and yet show the general phenomenon of evanescence exhibited by all odorants.

It is difficult to determine the solubility of a substance in the liquid present in the region of olfaction. A close approximation, however, can be obtained by considering solubility in water and in lipoids as essential.[25] Kremer[26] found that odoriferous materials like pyridine, citral and guaiacol were taken up in greater amount by lecithin solution than by water. Similar experiments with other proteins indicated that at least some powerful odorants are more soluble in protein solution than in water. It appears that solubility in protein or fats is a major factor and the solubility in water plays only a secondary role.

The third essential point is that the molecules of odoriferous substance should have either one or more of certain osmophore groups or certain type of mocecular architecture which can excite vibratory motion in the fibres of nerve endings in the region of olfaction. A necessary corollary to it is that substances having similar molecular set up or possessing same osmophoric groups should possess similar odour. From a large amount of data now available it can be said that broadly speaking substances belonging to the same chemical group do exhibit more or less similar odours. In many cases deviations from this generalization can be traced to the volatility and solubility factors. In this connection interesting data has been quoted by Dyson. He has tried to establish a relationship between odour and Raman shifts. Some of his data is illustrated in Table 2.

TABLE 2

Raman Shift	Type of odour
1,500	...
1,600	Imines.
1,700	Aldehydes and Ketones.
1,800	Esters, Terpene aldehydes.
1,900	Acyl chlorides.
2,000	...
2,100	Acetylenes.
2,200	...
2,300	Chlorinated aromatic hydrocarbons.
2,400	...
2,500	Mercaptan and allied odours.
2,600	...
2,700	Ether types
2,800	Higher aliphatic hydrocarbons
2,900	...
3,000	Aromatic hydrocarbons.
3,100	...
3,200	Heterocyclic and amine bases.
3,300	Pyridine, Pyrrole.
3,400	...

According to Dyson substances showing Raman shifts below 1,400 and above 3,500 are not perceptible to man.. Exception to this rule are, however, known

e.g., glycerine,—which possesses a measurable vapour pressure and lipoid solubility, shows also Raman shifts[27] at 466, 2880, 2,955, 3,202, is practically odourless. Nevertheless it is apparent that there is no doubt about a close relationship between Raman shift and odour. It may be pointed out here that the quality of odour has been considered by Dyson in terms of characteristic chemical groupings present in the organic odorants.

The fourth factor to be considered here is the physiology of odour. It has been stated that molecules of an odoriferous substance come in contact with the fine olfactory flagella present in the region of olfaction and set them to vibrations. These vibrations are then carried by afferent fibres of olfactory nerve to the olfactory bulb of the brain and cause the sensation of odour. Here it may be pointed out that a purely chemical basis for the physiology of odour is untenable. It is difficult to comprehend on a chemical basis the phenomenon of cancellation of odour. Many cases are known where a mixture of two odorous substances is practically odourless. The following cases were observed by Zwaardemaker,[28] *viz.*, rubber and cedarwood, rubber and wax, rubber and paraffins, rubber and balsam of tolu, tolu balsam and wax.

In this connection it may also be stated that various patents have been taken out from time to time which describe methods for masking or annihilating unpleasant odours of medicine.[29] This phenomenon can be readily understood on the basis of vibrations of flagella as the interference of opposite kind of induced vibrations in the flagella by two odorously opposite substances. Moreover the fact that fatigue for odour will not affect the perception of other dissimilar odour but will interfere with the perception of similar odours can also be readily understood.

From this brief review an interesting fact about the quality of the odour is brought to light. In the past various attempts have been made to classify odours. Mention may be made of the classification of Rimmel, Zwaardemaker, Henning, Parry, Crocker and Henderson and Erb.[30] In Table 3 are indicated the essentials of these classifications.

From Table 3 it is apparent that these classifications are purely arbitrary. It may be useful from the point of view of perfumer to have some such classification but it is doubtful if such an arbitrary classification can ever lead scientists to the fundamentals of the problem. The quality of odour is not easy to define. Strictly speaking the only basis for characterizing an odour is the particular chemical compound itself. To the author it appears that there is a continuous gradation of odours. Just as the visible light consists of spectral colours which, are named violet, indigo, blue, green, yellow, orange and red, each colour merges into the other and there is a continuous gradation of wave-length of light from one end of the spectrum to the other, similarly, though odours may be defined by various names there

TABLE 3*

Author	Major heads in classification	REMARKS
I. Rimmel ..	(1) Rose, (2) Jasmine, (3) Orange flower, (4) Tuberose, (5) Violet, (6) Balsamic, (7) Spice, (8) Clove, (9) Camphor, (10) Sandal, (11) Citrine, (12) Lavender, (13) Mint, (14) Aniseed, (15) Almond, (16) Musk, (17) Ambergris, (18) Fruit.	These major heads were subdivided.
II. Zwaardemaker.	(1) Ethereal, (2) Aromatic, (3) Balsamic or fragrant, (4) Ambrosial, (5) Alliaceous, (6) Empyreumatic, (7) Caprilic, (8) Repulsive, (9) Foetid or nauseating.	
III. Henning ...	(1) Spicy, (2) Flowery, (3) Fruity, (4) Resinous or balsamic, (5) Burnt, (6) Foul.	Considered to be primary odours.
IV. Parry ..	Classified alcohol odours into six main classes.	
V. Crocker and Henderson.	(1) Fragrant, (2) Acid, (3) Burnt, (4) Caprylic.	Fundamental odours.
VI. Erb ...	(1) Infra odours, (2) Fragrant, (3) Empyreumatic, (4) Caprylic, (5) Acid, (6) Ultra odours.	

appears to be continuous gradation from one kind to the other. If it were not so substances like indole which in stronger concentration give a foul smell would not have given a pleasant jasmine odour in larger dilution. Such a view is also supported by the hypothesis advocated in this paper for the physiology of odour. If the odour is the ultimate result of vibrations of fine olfactory flagella it is easy to understand a continuous gradation in odour. Dyson's results (*vide* Table 2) are also in conformity with these views. Up till now various attempts have been made to measure the intensity of odour but none for measuring the quality of odour. If it were possible to determine the frequencies of vibratory flagella there is no doubt that we would come much nearer to the solution of the mystery of odour.

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* Besides these classifications perfumers usually employ Piesse's 'Gamut of odours' or Cerbeland's extension of Rimmel's classification.

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BLOOD PRESSURE*

N. M. BASU

PRESIDENCY COLLEGE, CALCUTTA

MAINTENANCE OF NORMAL BLOOD PRESSURE

NORMAL blood pressure is maintained by a combination of factors. A few important features in relation to each factor and the influence of alteration of any single factor on blood pressure are discussed in this paper.

It is not necessary either to discuss the way in which these factors operate in maintaining the normal blood pressure or to explain why the variations in blood pressure in arteries mainly and in arterioles to some extent, caused by the Systolic discharge of blood, are not ordinarily transmitted to capillaries and veins.

The important features of these factors are:—

(*a*) *Heart beat.*—The pumping action of the heart is influenced directly by venous return and reflexly by high blood pressure and veno-auricular distension, the former of which decreases and the latter increases its force and frequency.

(*b*) *Peripheral resistance.*—It is the friction offered to the flow of blood through the circulatory system and is determined (*i*) by the viscosity of blood, (*ii*) by the pressure in arterioles and capillaries and (*iii*) by the calibre of the arteriole determined by vasomotor action.

(*c*) *Viscosity of blood.*—Viscosity of a liquid is its internal friction, *i.e.*, the resistance to shear or flow. This resistance is manifested when one part of the liquid is at rest and another part in motion or when there is difference in velocity between two parts of a column of liquid. It is thus proportional to the velocity with which the particles of a liquid move past one another and also to the extent of the rubbing surfaces. If there are particles in suspension in the liquid (as corpuscles in the case of blood), the viscosity is greatly increased, owing to the fact that where a liquid is in contact with a solid, a film of it is held stationary, so that there is more friction in the whole mass of moving liquid. The viscosity of plasma is proportional to its protein content and is normally about half as much again as that of water, but that of blood is, in comparison with water, about 4·7 for normal males and 4·4 for females. CO_2 distends r.b.c. and therefore increases the viscosity whereas O_2 diminishes it as it causes shrinkage of cells.

This peripheral resistance is not due to friction between the blood and the walls of the vessels, because the layer in contact with the wall is stationary, but to that between the successive layers of the blood itself, extending to some distance from the wall, the magnitude of this friction depending on the viscosity of blood. It is obvious that as the layer of liquid next to the adherent and stationary layer rides or slips over the latter, the greater part of the kinetic energy of this moving tubular column of blood is wasted in overcoming the internal resistance between the two layers and accordingly this column moves slowly. As the tubular layer of liquid next to the slowly moving second layer glides past the latter, the resistance between these two layers is less and accordingly its velocity of flow is greater than that of the second. In this way the velocity increasing progressively towards the middle of the tube soon becomes maximal, so that in a wide tube as in the aorta

* Full text of the address with which the discussion on blood pressure was opened at a joint meeting of Physiology and Medical and Veterinary sections of the Indian Science Congress Association held at Delhi in January, 1947.

and big arteries a large 'frictionless core' of liquid moves on at the maximal velocity, but in a narrower tube, as in arteriole, or when the viscosity of blood increases, the frictionless core moving with the maximal velocity becomes smaller in extent. It is thus expected that in arterioles the total mass of blood would cause frictional resistance although this may be offset to some extent by reduction in the rate of blood flow through them, as the total cross-sectional area of arterioles emanating from an artery may be greater than that of the latter. Curiously enough it has been shown by Fahraeus and Lindquist[1] that the effective viscosity of blood varies with the size of the tube and is not so great relative to water in tubes of less than 0·3 mm. in diameter. It is generally about 2·2 or less, in comparison with water, in ordinary arterioles. The reason for this low viscosity is as follows: —as the initial blood enters the tube, a part of the plasma adheres to the wall forming a plasma layer, so that this initial blood flowing out of it is altered in composition. In the case of blood passing subsequently through the tube there is no such change in composition. In a small tube this plasma layer is not a negligible value, so that during the actual passage of the blood through the tube the corpuscular suspension has a relatively low concentration through the tube and the viscosity is consequently reduced. In spite of the reduced viscosity of blood in arterioles, the resistance in arterioles is greatest, as would be evident from Poiseuille's law, as modified by Hagenbach, about the volume of liquid (V) flowing in unit time (t) through a tube of length (l) having a cross sectional area (Q) when the fall of pressure between the two ends of the tube is $p-p'$:—

$$\frac{V}{t}=\frac{Q^2(p-p')}{8\pi\eta l}$$ where η is the viscosity of the liquid.

$$=\frac{(\pi r^2)^2\,(p-p')}{8\pi\eta l}=\frac{\pi r^4(p-p')}{8\eta l}$$ (r being the radius of the tube). As the velocity of blood flow (vel)

$$=\frac{\text{volume flow per unit time}}{\text{Sectional area.}}$$

$$=\frac{\dfrac{\pi r^4(p-p')}{8\eta l}}{\pi r^2}=\frac{r^2(p-p')}{8\eta l},$$

it is evident that the fall of pressure i.e., $p-p'=\text{vel}\times$ Resistance $=\text{vel}\times\frac{8\eta l}{r^2}$, resistance being equal to $\frac{8\eta l}{r^2}$

It will be seen from these considerations that on account of the small calibre of the arterioles the resistance to blood flow through them which is inversely proportional to r^2 would be very considerable inspite of reduced viscosity. The following illustration gives an idea of the effect of arteriolar constriction on blood flow and blood pressure:—

Let the constriction of an arteriole cause the shortening of its circumference by 16·5 per cent and its radius also to the same extent, a shortening which is not discernible by histological methods. Then the cross-sectional area would be reduced to 0·7 of its previous value and the velocity of blood flow, pressure head remaining constant, being proportional to r^2 like the cross-sectional area, would also be reduced in the same proportion and the volume flow being proportional to Q^2 would be reduced to $(0{\cdot}7)^2$ i.e. to 0·5 of its previous value. If the volume flow is kept constant by maintaining the same cardiac output, the pressure head would be doubled. Thus with a small, not easily discernible change in the calibre of arterioles, the mean blood pressure would be doubled, cardiac output remaining constant.

The resistance in the capillaries is much less than in arterioles, inspite of their calibre being much less than that of arterioles and the viscosity of blood flowing through them being greater than that in arterioles. This is because the total cross-sectional area of capillaries being several hundred times greater than that of aorta (between 300 to 800 times), the velocity of flow through them is very much reduced, being about 0·5 to 1 mm. per second as against 22 cm. per second in aorta under basal conditions and 5 to 10 times this value after heavy exercise. As the frictional resistance is proportional, approximately, to the square of the velocity which is very low in the capillaries, it is obvious that the resistance in them would be still lower. (The apparent viscosity of blood in capillaries is increased because as the blood enters the capillaries the corpuscles cannot pass without being distorted, the distortion taking up a part of the energy of the current and thus increasing the apparent viscosity of blood).

The resistance in arteries and their branches is also low for the following reasons: —

(*i*) The arteries are wide and therefore the effects of viscosity are less pronounced.

(*ii*) The angles at bifurcation of arteries being greater than 75°, and the cross-sectional area of the branches being about 1·26 times the parent lumen, there is minimum dissipation of energy in the flow of blood at the bifurcation. Further, the "Indian Club" arrangements at many bifurcations prevent a turbulent flow.*

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*The turbulent flow results when the velocity in a tube increases beyond a critical value. Then the difference of velocity between axial and peripheral streams not only increases, but components tend to develop at right angles to the stream. In consequence, eddies or whirls are formed and cause the stream to become turbulent. Under such conditions murmurs or hums are heard with a stethoscope. In normal circumstances the high viscosity of blood prevents eddy formation.

The resistance in veins is slight, partly because they are wider than corresponding arteries and the velocity of blood flow is also less than that in arteries.

It is thus obvious that peripheral resistance resides mainly in arterioles. That the greater part of this peripheral resistance resides in the arterioles of the abdominal viscera is evident from the fact that when these are fully dilated, the blood pressure tends to be reduced to zero.

(d) Volume of blood.—If the volume of blood is reduced considerably during haemorrhage, the blood pressure may be lowered to $\frac{1}{3}$rd of its normal value inspite of cardio-vascular reflexes which control the capacity of circulation.

(e) The elasticity of arteries, particularly that of aorta plays a great part in maintaining the blood pressure by accommodating nearly half of the ejected blood during systolic discharge and driving out this blood on account of elastic recoil in between the systolic discharges. But the question of elastic recoil does not arise, if there be no stretching of arteries. At a blood pressure below 40 mm. Hg, there is no stretching and therefore, no elastic recoil, and hence the arteries behave under such conditions as rigid tubes. If the volume-elasticity curves of aorta, *i.e.*, $\frac{dp}{dv/v}$ (or ratio of pressure increase to per cent increase in volume) obtained post-mortem from persons of different age groups are taken, it is found that while in young persons the curve is essentially a diagonally straight line over ordinary ranges of pressure, with the advance of age it tends more and more toward the horizontal line at progressively higher internal pressures. These age changes are associated with progressive increase in wall thickness, diminution of elastic tissue and increase in collagenous fibres. It is, however, interesting that inspite of this usual increase of aortic rigidity with age, the elasticity is fairly constant in the physiological pressure range, for the curves pass through almost the same elasticity point in this region.[4] When a wave passes through an elastic tube filled with liquid it tends to distend it laterally and to cause elongation. The repeated transmission of the pulse wave through aorta and its tributaries, the wave being naturally at its peak in the aorta, causes a gradual increase in its diameter and length, accompanying the increase of aortic rigidity with age. But the aortic elongation is opposed by various branches of the aorta with their connective tissue sheaths which tend to act as anchors. Consequently the aorta gradually becomes tortuous with age.* These changes in aorta greatly offset the deleterious effects of decreasing elasticity with age. An example will make it clear. If we assume aortic volumes as 200 c.c. and 300 c.c. at 20 and 40 years, and the systolic discharge to be 50 c.c., the relations $\frac{dv}{v}$ (expressing the percentage increase in the systolic volume of aorta) would be $\frac{50}{200}$ and $\frac{50}{300}$ *i.e.*, $\frac{1}{4}$ and $\frac{1}{6}$. Thus the enlarged aorta does not need to expand as much to accommodate the same systolic discharge. This being the case, the pulse pressure (*i.e.*, the difference between systolic and diastolic pressures) is expected to be lowered with age. But this is not always true. For recently evidence was obtained that a significant increase of internal pressure activates the aortic muscles which by their contraction detense elastic elements and thus increase aortic elasticity.

* Tortuosity in aorta alters its distensibility, since a greater stretching force is developed when a wave is reflected round a bend. This effect probably intensifies the reservoir function of the aortic arch which tends to be reduced in old age.

Effects on blood pressure of variations of each of these factors.—(*a*) Increase in heart rate without any alteration in minute volume, peripheral resistance or other factors causes a diminution of stroke volume and an increase in diastolic pressure but has a slight effect on systolic pressure, whereas increase in minute volume alone causes a greater rise in systolic pressure which leads to a greater outflow of blood from the arteries through arterioles during diastole. Consequently diastolic pressure cannot appreciably rise and accordingly the pulse pressure is high. (*b*) Alteration in peripheral resistance or blood viscosity affects both systolic and diastolic pressure but the latter more than the former. As peripheral resistance is essential for the maintenance of diastolic pressure its increase or decrease by affecting the outflow from the arterial system, will influence the diastolic pressure directly and more considerably than the systolic pressure. (*c*) Changes in the total volume of blood will affect both pressures. (*d*) Reduction in elasticity of larger arteries alone will tend toward a lowering of diastolic pressure but when there is an associated narrowing of peripheral vessels, as in arterio-sclerosis, the diastolic pressure may be raised, rather than lowered.

Measurement of Blood Pressure

Two well known methods for its determination are palpatory and auscultatory. In palpatory method, as pulsation cannot be definitely felt until the cuff pressure is lowered 5 to 10 mm. below the point when the artery becomes pervious, it gives low readings for systolic pressure. Further, the determination of point of maximum oscillation as giving the diastolic pressure, is neither easy nor quite accurate, for the maximal oscillation is noticed in instruments not merely at a particular point but within a certain range. The auscultatory method is certainly better than the former, but sometimes the muffling of the sound is followed almost immediately by its disappearance. The stethescope bell should be applied

as lightly as possible to the elbow, for if applied forcibly, it may compress and distort the vessel and give rise to sounds and may increase the pressure due to water-hammer effects.

In both these methods certain inaccuracies are likely to occur. These are :—

(*i*) The resistance of the tissues and the arterial wall to the compressing force of the armlet is variable and is likely to cause inaccurate reading. The error due to this factor is mitigated by the use of a broad armlet (12 cm. in width)* ; (*ii*) Mercury manometers are physically unsuited to record pressure fluctuations during systole and diastole on account of their inertia. This is particularly evident at very slow heart rates when there is overshooting of mercury both during ascent and descent ; at very rapid heart rates the inertia of mercury prevents full systolic and diastolic pressures from being recorded. If, however, the pressure tubing connecting the artery or the cuff and the manometer be sufficiently constricted ; the mercury system can be so damped that only minute oscillations of pressure occur.

In recording pressure variations in carotid artery of normal unanaesthetized dog by hypodermic optical manometer it is noticed that over a range of 5 beats diastolic pressure varies from 80 to 90 mm. and systolic pressure between 120 and 136 mm. These are due to effects of quiet respiration and a slight degree of Sinus Arrhythmia and are much intensified when respiration is deep or forced and marked irregularity exists. The physician should remember these normal variations in estimating the blood pressure of persons. In extreme arrhythmia, pressure recordings have no significance whatsoever.

Variations in blood pressure in different parts of the arterial tree.—It is found that the systolic pressure measured near the iliac bifurcations is actually higher than at the root of the aorta. This is also true in the case of femoral or other peripheral arteries. This is brought about in either of the following ways :—

(*a*) The pressure increments in tubes in a system in dynamic equilibrium, *i.e.*, one in which the constant pressure decrement and a constant flow obtain, may be brought about by what is known as 'Water-Hammer.'

Water-hammer is a term used to describe the sudden development of pressure in a hydrodynamic system in equilibrium, when the flow of a moving column is suddenly checked, as in the case of occlusion of an artery or when the stream of blood through an artery, on reaching the arterioles, meets resistance, broadens and is slowed. In such cases the kinetic energy of flow is transposed to stress or pressure. Such 'water-hammer' effects are noticed when the maximum blood pressure is recorded by low frequency manometer, *viz.*, Hg-manometer, in the ascending limb of the radial pulse on account of the greater velocity of ventricular ejection than the run-off from the arterial system and in aortic insufficiency when the rate and the amount of the ventricular ejection is much increased due to low diastolic pressure and to overfilling of the ventricle which causes a greater stroke volume. In this last condition the 'water-hammer' effect is very pronounced and the pulse under such conditions is called 'water-hammer pulse'. The fluid behind the site of stoppage or resistance under these conditions not only comes into equilibrium with the level of liquid in the reservoir or with the blood pressure at the root of the aorta, but exceeds it temporarily partly due to rebound and partly due to 'water-hammer'.

(*b*) Pressures may also be augmented in peripheral regions by the operation of what is known as the *Venturi principle*, in so much that fluid apparently flows under such conditions from lower to higher pressure. The *venturi principle* is an application of Bernoulli's theorem which states that, discounting loss of energy by friction, the total energy remains constant. The total energy of a fluid at any point in a system of dynamic equilibrium may be expressed by its pressure and velocity at that point, *i.e.*, by $P + \frac{mv^2}{2}$. As the total energy is constant, $P + \frac{mv^2}{2} = P_1 + \frac{mv_1^2}{2} = P_2 + \frac{mv_2^2}{2}$ where P & V, P_1 & V_1 and P_2 & V_2, represent the pressure and velocity at different points. If the stream bed is rapidly constricted and then somewhat gradually widened, the pressure energy at the constricted portion is partly converted into flow energy, causing a decrease in pressure and increase in flow at that portion and then at the dilated portion there is reconversion of flow energy into pressure energy causing thereby an increase in pressure and slowing of movement of liquid. The movement of fluid under such conditions from a place of low to one of high pressure is possible, if the kinetic energy of flow be sufficient to counterbalance the difference in pressure. The venturi effect operates during ejection of blood through partly closed semilunar valves and during aortic stenosis.

(*c*) Increase in pressure in peripheral arteries may also be due to superimposition of reflected waves in a complex way. Higher pressure in the femoral artery or near the iliac bifurcation is mainly caused in this way.

* A wide cuff helps to mitigate the error due to compression of tissues and arterial wall in the following way : If we assume that the pressure required to overcome the compression of tissues etc., be 4 mm., then when the extra-arterial pressure is made equal to the arterial pressure, a feeble pulse wave will start to pass under the cuff, but will have too little force to penetrate the entire length of the compressed vessel.

Normal Valves for Human Blood Pressure

The brachial artery in man and the common carotid of animals show a form of pulse similar to that of aorta. Hence readings of systolic and diastolic pressures of these[1] vessels are taken to be a reliable index of aortic pressure.

Various estimates of these pressures are given by various writers. According to American writers systolic pressure rises gradually from 120 mm. at 20 years to 150 mm. at 65 years and diastolic from 70 to 85 or 90 mm. According to English writers the usual normal range of systolic pressure is 90--120 mm. and diastolic pressure 60--80 mm. The "mature" pressure is reached in adolescence and does not rise with age. The upper limit of systolic and diastolic pressures are 140 and 90 mm. respectively.

Direct optical registrations of brachial pressure show that newborn babies have average pressures of 80/46 mm(8·1/8·2). Then there is a gradual increase of pressure up to adolescence. Roughly, the pressure are at 3 years $\frac{80}{56}$, at 6 years $\frac{85}{58}$, at 10 years $\frac{95}{58}$, at 14 year $\frac{113}{68}$ and at 16 years $\frac{120}{78}$. In girls variations in blood pressure are the same as in boys upto pre-adolescence. Between 10 and 12 years the systolic pressure of girls tends to exceed those of boys; but after puberty pressures in males exceed those of females and continue to be so throughout normal adult life. The blood pressures in old people rapidly rise between 62 and 85 and then begin to decline.

Emotional states such as fear, excitement and worry lead to increased liberation of adrenalin which causes an increased rate of stroke volume of the heart and thereby increases the blood pressure, particularly the systolic pressure. Restful sleep lowers the systolic pressure by 10 to 30 mm. and diastolic pressure by 5 to 10 mm. Exercise increases both systolic and diastolic presures, particularly the former. The maximum increase in pressure is roughly proportional to the severity of the exercise, the minute output of the heart being nearly proportional to the O_2 consumption of the individual during the period of exertion. When the exercise ceases, there is a sudden drop of the systolic pressure due to relaxation of abdominal muscles. This is followed by a secondary rise which is roughly proportional to the exertion and which continues for several minutes.

The diastolic pressure is always lower in the recumbent posture than in the upright *i.e.*, sitting or standing position. In the upright position the pressure in the femoral artery is greater than in brachial artery, owing to gravitational effect. When a person stands or sits up, the systolic pressure usually increases less than the diastolic pressure. A small increase in the systolic pressure occurs after meals.

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ORE-DRESSING : ITS POTENTIALITIES IN INDIA

M. R. MENON,

GARLICK AND COMPANY, BOMBAY

Ore is defined as the metalliferous rock from which metal or metallic compound may be extracted commercially. It is the raw material of metalliferous industry.

The crude ore as mined consists of (*a*) the valuable metalliferous mineral, (*b*) Non-metalliferous gangue mineral, (*c*) A proportion of the country rock. In the above complex condition the crude ore is generally unsuited for extraction of metal by direct metallurgical operations and more so because metallurgical operations require a small condition, sometimes that of impalpable powder.

The operations which come in between those of mining on the one side and metallurgy on the other which result in removing the gangue as far as necessary or expedient, along with those operations which bring about the size reduction, constitute the art of ore dressing. Obviously the dressing operations effect a mechanical and preparatory concentration of the valuable constituents whereas metallurgical operations effect a chemical and final concentration. It does not follow from the above that ore-dressing is taken to include such calcining or roasting as may be necessary to induce magnetism preparatory to magnetic separation or as is necessary to break up a sulphide or an arsenide preparatory to subsequent water separation ; or such as may be employed in the preparation for differential flotation. From the above it is obvious that ore-dressing as is understood in

present day technique, includes every operation after the mining of the ore and before the metallurgical operations ; and reasonably dressing can be described as concentrating also.

Why is dressing of ore a necessity? Why should not ore from the mines be sent direct to the smelter? The importance of dressing is originated from the physical and mineralogical difference between the crude ore and ore suitable for metallurgical treatment or for direct use. On the basis of such differences dressing becomes a necessity for the following objects: (1) to reduce the ore to a proper size, (2) to remove the gangue to the extent necessary, (3) to remove the interfering minerals as completely as possible, (4) to separate different ore-minerals occuring together. More than being a necessity, dressing has the following specific advantages mostly from the economical stand point.

Firstly, where smelting follows there is less material to smelt after dressing. Leaving out of consideration the costs of converting, refining etc. which depend upon the metallic contents eventually recovered, smelting is more costly than dressing, for it has been estimated that the cost of smelting is three times that of dressing itself.

The second advantage comes from the saving in cost of transportation to the smelter. This is particularly so when the ore has to be sent hundreds of miles by land or thousands of miles by sea for export purposes. Moreover there is the saving in cost of taxes and duties which fall needlessly on low grade ores if sent for export, straight from the mines.

The regular character of the dressed ore facilitates smooth handling by the smelter. In addition to removing the gangue minerals and country rock, passage through the concentrating plant removes also the irrigularities characteristic of crude ores. Accordingly the material which eventually passes to the smelter is of such regular chemical and mechanical character that in the provision of flux, the margin of safety may be reduced and charges are made up more economically.

Even with all the above advantages, it is said that the dressing operations usually sustain a relatively large loss of mineral. Even allowing for the maximum losses sustained in such operations and considering the saving in freight also, it is established that dressing operations have a definite place in mining and metallurgical industry on price to price basis. The following pre-war costs (fraction of the present day costs) will convince every mine owner that dressing is a system which should advantageously be introduced to his mines.

Dressing including both milling and concentration could be accomplished at an operating cost of Rs. 3/6/- per ton ; smelting would cost Rs. 10/-. When a dressing plant costs Rs. 1000/- per ton treated per day, a smelting plant would cost Rs 2000/- per ton a day. Considering interests and amortization of these capital sums as part of the cost the full cost would be about Rs. 3/13/- and Rs. 11/- respectively.

As ores exhibit large variation in their necessary reduction in bulk after dressing it is necessary to calculate the operating cost freight, capital cost etc. for two different concentrations. Assuming that in one case the reduction of bulk after dressing is one half the material treated and in another case generally to about one tenth, the comparative cost can be calculated in the following way.

	Cost per Ton	Operating loss	Freight	Cost total	Cost dressing, freight, smelting, loss of crude ore per ton.
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	
1st case.					
2 tons directly smelted at	11 5 6	2 12 0	6 14 0	41 15 0	20 15 6
2 tons crude ore dressed at	3 15 3	2 12 0		13 6 6	
1 ton smelted from the above at	11 5 6	2 12 0	6 14 0	22 3 6	17 13 0
Saving in cost , ...				35 10 0	3 2 0
2nd case.					
10 tons smelted directly at	11 5 6	2 12 0	6 14 0	209 11 0	20 15 0
10 tons dressed at	3 15 3	2 12 0		67 0 6	
1 ton from the above smelted at	11 5 6	2 12 0	6 14 0	+ 22 3 6	8 14 0
Saving in cost				89 4 0	12 0 8

Figures in the 1st case is entirely in favour of dressing showing a saving of about 18% on the smelting cost, those of the second case shows a very great advantage in favour of dressing, showing a saving cost of more than 134% ! Almost all Indian ores come within the range of first and second cases and

there is no doubt about the importance and the potentialities of ore dressing in India.

The foregoing calculations are given to illustrate the possible effect of operating cost, operating loss and freight upon the question of dressing. With crude ore suitable for direct metallurgical treatment these considerations largely determine whether dressing should be applied or not. More generally however crude ore is not amenable to such direct treatment especially in India, and therefore dressing is a technical and economical necessity.

In India although possessed of a large mineral wealth, dressing as a technical necessity is not yet recognised due to (1) the vast resources of mineral wealth which have not yet been properly investigated; (2) the ignorance as well as the deliberate business policy of mine owners; and above all, (3) political considerations.

The first point is evidenced by the lack of proper authoritative report on the mineral resources, the Geological Survey of India of late has taken up this matter more seriously.

The second point can be seen to be true from the very structure of present day ownership. It is the practice nowadays to allot leases of rich mine lands to some mining companies or private individuals who either just sit upon it striking a bargain with foreign agents or themselves having not enough capital and resources to effectively prospect the mines. Even if the mines are properly prospected and found to be profitable with advanced technical methods, cases are not rare that the owners or lessees do not proceed with the work of exploiting for reasons known to themselves. Moreover in a large number of cases especially during the war years it has been considered by the lessees and owners of mines an easier way to just sell off the crude ore to foreign processing companies. It is high time that these industrialists realise that if India's economic minerals are processed in India itself, it will alleviate the largely looming unemployment among Indian working class and it will fetch the owners a better value and a higher percentage of profit.

The third point needs no better clarification than to understand the policies of the then ruling power. It may be pointed out here that the gold mines and copper deposits of India are controlled by foreign people. Let us expect that with the President of the National Planning Committee in the leadership of Government, all such anomalies and anachronisms will be wiped out and stable mineral policy will be adopted. I am afraid it will be out of place on my part to advice our leaders and men of Industry on the adoption of stable mineral policy. However with the National Government in power, it is the legitimate duty of all progressive Indians to demand from it a stable mineral policy with broad objectives as follows :—

(1) All mineral wealth should be owned by the State.
(2) Introduction of advanced processing methods in India itself under the initiative of the Government and with the services of a few foreign experts at start.
(3) A scheme to assess the mineral wealth of India.
(4) Training of adequate technical staff to man the industry.
(5) The establishment of a central and a few provincial testing and research stations in different parts of India.

I am happy to learn that the Geological Survey of India and the Department of Works, Mines and Power together have initiated to prepare a scheme to establish a Bureau of Mines.

Plants and Equipments.—The subject of ore-dressing can be classified under the following heads from the view point of the operational practice.

(1) Washing and sorting.
(2) Comminution, including crushing, grinding and screening.
(3) Sizing and classification.
(4) Concentration and separation.
(a) Water, (b) Gravity, (c) Flotation, (d) Cyanidation, (e) Magnetic, (f) Electro-static, (g) Pnuematic and (h) Centrifugal.
(5) Heat treatments—drying, calcining, roasting etc.
(6) Control of operations, sampling, assaying, recovery and enrichment.

However it is regrettable that many of the equipments for the above operations are not manufactured in India. This lack of preparedness on the part of engineering industries in India may be attributed to the fact that our ore-dressing industry is in its infancy. Even then with the growth of Mineral Industry under the auspices of the proposed Bureau of Mines, the day is not far off when our engineering concerns will be in a position to supply all equipments for the above operations.

Future of Ore-dressing in India

In spite of all the defects and handicaps advanced against it for immediate execution, ore-dressing is bound to have a good future in India, more so due to the proposed mineral development schemes. Even if the mineral policy is not to be dictated by the Bureau of Mines, on the contrary dictated by the industrialists and private mine owners, it is inevitable and a technical necessity for future competition and processing economy that ore dressing

should be widely adopted. Moreover, under recent investigations it has been found that phosphatic rocks and graphitic minerals are amenable to concentration by the method of flotation etc. With the result the low grade Indian graphite can be made to compete with Ceylon or any other graphites. The introduction of froth flotation methods in the purification of low grade coal is another example of technical advance in the above line. Similarly all other minerals have to be dressed properly by technical methods if they are to be marketed economically, competitively and up to the standard.

INSTITUTE OF NUCLEAR PHYSICS

THE foundation stone of the Institute of Nuclear Physics of the University of Calcutta was laid on April 21 last by Dr S. P. Mookerjee, Minister, Industries and Supplies, Government of India at 92 Upper Circular Road, Calcutta.

While laying the foundation, Dr Mookerjee said that he hoped that the Institute would become the nursery of nuclear scientists for the service of India and make contributions of a fundamental nature in atomic science.

The Calcutta University has been the pioneer in India in recognizing the importance of atomic energy research. It is nearly seven years that the University took the first steps in this matter, thanks to a gift obtained from the Tata Charities of Bombay through the efforts of the present Prime Minister of India. In spite of conditions created by war, famine and the apathy of the Government then in power, our workers have been actively engaged in building up the laboratory and contributing their share of research, some of which have received international recognition.

Continuing Dr Mookerjee said that Government of India have appointed a committee under the chairmanship of Prof. G. R. Paranjpe of Bombay for giving them plans for a Scientific Instruments Establishment which will be capable of producing all the scientific apparatus and instruments needed by India's scientific men, technicians and industrialists. Further export of such materials, *i.e.*, manganese, mica, monazite, beryl, finished jute products and tea, should be regulated on a barter system for such of our immediate necessities as petrol, machineries and scientific instruments.

Concluding he said the Government of India are already considering the question of assuring continuity of the grant which this Institute has been receiving from the Council of Scientific and Industrial Research for the last two years. He hoped our industrialists and capitalists would come forward with offers of permanent endowments for the creation of research fellowships at the Institute.

Requesting Dr Mookerjee to lay the foundation stone Prof. P. N. Banerjee, Vice-Chancellor, Calcutta University, said: The history of the project dates back to 1940 with the gift of a sum of Rs. 60,000 for purchase of materials for a Cyclotron machine from the Dorabji Tata Trusts of Bombay.

The task of the purchase of the machine was entrusted to Dr B. D. Nag Chaudhuri then working under the inventor of the Cyclotron, Prof. E. O. Lawrence, in the Radiation Laboratory, Berkeley, California, now *Sur Reader in Nuclear Physics* in the University of Calcutta. The materials started arriving from the end of 1941 notwithstanding difficulties created by the World War II.

The University from out of its fee fund has contributed to the Cyclotron scheme the sum of Rs. 1,63,325. The installation of the interim Government, with Pandit Jawaharlal Nehru at the head, led to a capital grant of Rs. 70,000 and a recurring grant of Rs. 40,000 for two years by the Government of India for completing our equipment.

The Tata gifts were followed by other gifts. Mr Ranadaprasad Saha made a gift of Rs. 45,000 for the purchase of one gram of radium from Canada. This quantity of radium with its plant cost the University Rs. 81,323.

Dr B. C. Law made the gift of Rs. 17,500 for the purchase of an Electron Microscope which has cost the University a sum of Rs. 39,000. Dr N. N. Dasgupta, *Reader* in *Biophysics* in the University of Calcutta, has come back from the Stanford University, California with a knowledge of the technique of Electron Microscopy. This instrument will enable a magnification of 1,00,000 diameters, is the first of its kind in India, and would be of great help in bacteriological and biophysical problems.

The building for the Institute will have an area of 25,000 sq. ft. With services and equipments it is estimated to cost a sum of Rs. 5,50,000. The Government of West Bengal has made a provision for Rs. 2,00,000 for the erection of this building for Nuclear Physics.

An institution of this type requires large recurring expenditure. The University budget for 1947-48 has been able to make provision for only Rs. 1,16,615. The University of Glasgow, which has been recognized as one of the six centres of fundamental research in Nuclear Physics in England, has a recurring budget grant of £17,000 per year in addition to its ordinary budget of £29,000. The University of Peiping which is soon going to have a Nuclear Physics Laboratory has, budgeted 4,00,000 American dollars equivalent to Rs. 16,00,000 in our currency, for converting the Radium Institute of China to an Institute of Nuclear Physics. It will have a Cyclotron of our size.

For our recurring expenditure, the Palit Trust Fund can perhaps make a provision of Rs. 34,000. The fund donated by M. M. Sur for the creation of a *Readership in Nuclear Physics* may yield a sum of Rs. 6,000. With the consent of the generous donor, this fund (Rs. 2,00,000) is being utilized for the construction of the Nuclear Physics building. The University will maintain the Readership out of its fee fund, and create a sinking fund for the purpose of liquidating its obligation to the donor in the course of the next ten years. The position of the fee fund of the University is precarious due to the partition of India and the division of Bengal and, have led to a financial loss of about Rs. 10,00,000 in fee fund. In the year 1948-49 it is hoped to utilise the annual grant of Rs. 12,000 from the great industrialist firm of the Birlas, and Rs. 6,000 from the Tata Trust Funds. Both these funds are yet on a quinquennial basis. The Vice-Chancellor pleaded for the grants from the Government of India, from Messrs. Birla Brothers and Tata Sons Ltd. being placed on a permanent footing.

Proposing a vote of thanks to Dr Mookerjee, Prof. M. N. Saha, President, Council of Post Graduate Teaching in Science, Calcutta University, said: The Institute is dedicated to fundamental researches in Nuclear Physics, Nuclear Chemistry, and Bio-physics. The object is advancement of knowledge, and it is to this objective that the present Institute is dedicated, as far as Atomic Energy is concerned.

In this context it is necessary to stress that both U.K. and U.S. Governments have agreed upon a policy of decentralization of Nuclear Science research. In both these countries there are two types of institutions. Firstly, the semi-military type of establishment like that at Harwell in England, or at Oak Ridge in U.S.A. There work is done under strict security conditions and with funds supplied by Governments. Such institutes are concerned mainly with the problem of utilization of atomic energy either for military or industrial purposes, They are capable of tackling big problems like that of construction of piles, separation of fissionable isotopes on a large scale and are also trying to retain some features of free university life.

The second type of institutions in which large scale atomic researches are being carried out, are the famous universities and technical institutions which, by tradition as well as on account of highly trained personnel, are well suited for fundamental researches. To these institutes large sums of money are paid by Government without any tags attached to the grants. The universities are free to receive any outside grants and also to carry on research on any aspect of Nuclear Physics.

Continuing Prof. Saha gave a brief account of the work done at the University. On the constructional side the work of assembling the Cyclotron parts were finished long ago. The magnet, the power installation, the ion source have all been working very satisfactorily yielding beams of several micro-amperes. Unfortunately the pump system which was ordered from America was lost in Singapore in 1942 and in spite of the best efforts we were unable to find out a suitable substitute. The C.S.I.R. gave us a grant for manufacture of pumps during war and we were able to produce types up to a certain standard of performance, but their suction capacity was not sufficient for our purpose. The recent ban by America on export of scientific equipments particularly vacuum equipments which can be used for atomic research, makes the situation still worse. A similar state of affairs is also happening in Europe and a 60 inch Cyclotron which had been undertaken in a certain British University could not be made to work satisfactorily for their failure to procure good pumps. He hoped to overcome these difficulties soon.

In our workshop we have elaborated the technique of Geiger counters for the study of cosmic-rays, β-rays, γ-rays and neutrons. We have also constructed and operated successfully Wilson cloud chambers of large size. No Nuclear Physics research is possible without a regular supply of efficient instruments for detection of nuclear projectiles, *e.g.*, G.-M. counters, Wilson cloud chambers, Ionization chambers, β-ray spectrographs, etc. In this field we have thoroughly mastered the technique. Our scholars have constructed a number of β-ray spectrographs and measured the β-spectra of nuclei and have made important contributions. The thesis submitted by one our scholars (Dr A. K. Saha) for Doctorate degree evoked warmest appreciation from the examiners, Madam Curie Joliot, Profs. Ellis and Born. Our workers in Cyclotron under the guidance of Mr B. M. Banerjee have worked out electronic devices for the various parts which we consider very ingenious for the purpose.

Theoretical methods have been evolved in the location of β-ray spectra of radioactive nuclei which have succeeded in bringing certain amount of order in the nebulous field of β-activity. Methods of estimating age of rocks by determining the α- and β-

activity of rocks containing Thorium and Uranium have been developed in our laboratory. The β-activity method due to Dr Nagchaudhury is entirely original in conception.

Concluding Prof. Saha referred to his Theory of the Solar Corona on the hypothesis of tri- and quadri-fission of Uranium and other nuclei which was found probable on theoretical grounds. These hypotheses have been verified only last year by a Chinese couple working in the laboratory of Joliot Curie in College de France, Paris.

The fascinating subject of cosmic rays has not yielded all its secrets yet to the investigators. Dr N. N. Dasgupta and Dr P. C. Bhattacharya have made a fundamental contribution by measuring the life of meson at rest in 1940. Dr Bhattacharya has recently been awarded the degree of Doctor of Science for ingenious devices for studying mesons, by three examiners particularly eminent in the field, *viz.*, Dr Rossi, Italian physicist now in the States, Prof. Auger of France and Dr Swann of Bartol Research Foundation, Philadelphia. The work of Dr S. C. Sirkar and Mr P. K. Bhattacharyya on a light kind of neutral cosmic particle carried out in 1942 has been verified in other laboratories of U.S.A. and England.

Notes and News

THE SCIENTIFIC CRIME LABORATORY

THE basic function of police laboratory is that of augmenting regular police methods of linking the criminal to the crime by the scientific examination and evaluation of possible evidence.

A crime detection laboratory-truck is fitted with several thousand dollars worth of diversified scientific equipment. It usually has two X-ray units, a motor generator set, a complete photographic dark room, finger print detection apparatus, microscope, camera, a small chemical laboratory, ultra-violet lamps, an electro-magnetic retrieving arm for the recovery of weapons, a time bomb detector, fluoroscopic equipment, plaster-casting apparatus and a host of other machine tools. The list shows the number of trained hands needed in a modern police laboratory. Obviously the equipment of the head quarters laboratory is more diversified than the mobile unit. A few of these accessories are shown in the list of various lens of the head lights of cars, list of various dry cleaner's mark and laundry mark.

The list of the lens of the head lights comes into use in hit and run cases. It consists of samples of lenses of every type of head lights of cars. The list is indexed according to the diameter of the lens and notch arrangement. By knowing the nature of the lens, the type of the car can be recognized. The particles of paint from the car, found on the victim's clothing are compared spectrographically with those of the suspected car, and the tyre track is also checked with the latter's tyre.

The list of different dry cleaner's mark and laundry mark is kept up to date, noting the change in marking methods. Specimens of hand-writing of employees in charge of marking garments at different cleaning establishments are also kept. Ultra-violet light of various spectral ranges is necessary to reveal the marks of laundries which use invisible fluorescent ink to avoid disfiguring of the garment. Similarly ultra-violet radiation is used in revealing hidden writing on documents and in photographing finger prints on multicoloured surfaces.

Infra-red photography is employed to locate the circle of unburnt powder particles that surround the bullet hole on the victim's clothing. The radius of the circle is proportional to the distance at which the gun is held. Semipenetrating 'soft' X-rays are used to locate on the victim's clothing the lead particles that are shaved from the bullet by the bore of the gun and which follow it to its target. These bits of lead arrange themselves around the bullet hole at a distance which indicates the distance of the gun from the victim. Some interesting uses of the spectrograph may be noted :

(*a*) When examined under a stereoscopic camera, a knife blade broken off in the victim's body was found to fit perfectly into the fractured part of the hilt found on the suspect. The composition of steel

of both the parts were found to be identical spectrographically.

(*b*) The spectrograph of a crystal of a watch found at the scene of a burglary coincided completely with that of a fragment of glass which remained stuck on the wrist-watch of the suspect.

(*c*) The spectrograph of the dried mud on the shoes led to the arrest of a suspect, for it was identical with that of the mud under the bushes where the victim was found.

The microscope and the camera often supplement other apparatus and technique. Then comes chemical analyses, say for blood, poisoned food, protein matter, etc. The atmosphere of the room where the dead body is found, is examined for poisonous gases. Chemicals are used in the relevation of invisible finger prints. The underlying chemistry of such visibility of finger prints is simple and interesting. The body fluid which is responsible for the finger print consists chiefly of an aqueous solution of sodium chloride with a 1 per cent mixture of fatty acids. When the print is old, much of the water has evaporated and it is difficult to obtain a good photograph. In such cases, the surface is exposed to iodine fumes which revive the mark by adhering to the outline of the fatty acid residue. In cases where this method is not applicable, the surface is moistened with a solution of silver nitrate which converts sodium chloride to silver chloride, which darkens when exposed to light, giving a clue to the finger mark.—*Chemical News*, February 16, 1948.

APPLICATION OF ACETYLENE CHEMISTRY

THERE must be few organic compounds which could compete with acetylene in versatility of reactions combined with general usefulness as a basic material for chemical industry. Germany had built her industry during war time for the manufacture of the major aliphatic organic chemicals around acetylene as the basic starting material, largely because of the shortage of molasses and petroleum. The hydrogenation of acetylene to ethylene on a scale approaching 50,000 tons per year, and the production of aromatics from acetylene was envisaged in Germany, where acetylene was largely produced from carbide. Before the war the carbide production was divided equally between acetylene production, welding and the cyanamide industry, whereas during the war acetylene allocation was increased to 54 per cent. The most important German contribution to acetylene chemistry was the successful solution to the problem of working with acetylene under pressure, and detailed instructions were now available in Britain (laboratory notes taken from Germany) for the operation of those pressure reactions varying from the laboratory scale to the production of butinediol on a scale approaching to 50,000 tons a year.

The reaction of acetylene fell conveniently into three groups: polymerization, addition to the triple bond and reactions involving the active hydrogen atoms, *e.g.*, reaction with formaldehyde to give butinediol. The controlled polymerization of acetylene might proceed in several ways to yield a variety of well defined and useful products. On bubbling acetylene through a certain catalyst it was transformed to a mist of monovinyl acetylene and divinyl acetylene, together with small amount of higher polymers.

Monovinyl acetylene on reaction with hydrochloric acid, was transformed into chloroprene which might be polymerized to the valuable synthetic rubber, neoprene, which was manufactured on a very large scale in the United States and Russia and had attained great importance during the war. German production of neoprene, however, was very small and the Germans seemed to regard it as a speciality product.

The reaction of acetylene involving additions to the triple bond included the hydration of acetylene to acetaldehyde and the production of all the important vinyl compounds. In Germany, acetaldehyde was another key stone of industry, being used largely for conversion to butadiene.

Although the reactions of acetylene phenols in the presence of an alkaline catalyst would yield a vinyl ether, in the presence of zinc naphthanate, at elevated temperature and pressure yielded a vinyl phenol which usually polymerized spontaneously. The resulting polymers, when used in dilute aqueous solution attained considerable importance as blood plasma substitutes during the war. By heating an aqueous solution of trimethylene with acetylene under pressure neurine was obtained. The reaction of acetylene and carbon monoxide gave acrylic acid. Two authentic syntheses were now available for vitamin A itself from acetylenic compounds. Secondary acetylene carbinols were oxidized with chromic acid to the corresponding acetylene ketones.—(*Chemical Age*, 27th March, 1948).

THE CANARY SIGNAL

CANARY birds are easily susceptible to carbon monoxide gas. While a man feels only a slight headache at the end of 20 minutes in an atmosphere of 0·25 per cent carbon monoxide, a canary shows alarm in one minute and falls from its perch in 3 minutes. Canaries are nowadays employed at factories for producing petrol from natural gas and coal, to detect leakage of deadly carbon monoxide used in the process.—(*J. Chem. Education, 25*, 173, 1948).

CARRIER-DISTILLATION METHOD FOR URANIUM

Utilization of uranium as a source of atomic energy requires material of the highest purity. Impurities, such as boron and cadmium may interfere if present in concentrations as low as a few tenths of a part per million, and many other elements should not exceed a few parts per million. A spectrographic method of the analysis of uranium and its compounds was developed at the National Bureau of Standards in 1942 and was used in the Manhattan Project. The bureau has applied the method to control and inspection in the production of uranium compounds. Interference of the highly complex uranium spectrum (in which more than 20,000 lines have been observed) with the spectral lines characteristic of impurities was overcome only by separating the impurities from the uranium by carrier-distillation method. The uranium sample was converted to a refractory compound having low volatility (the black oxide of uranium U_3O_8) and the impurities were removed from this compound in a direct current electric arc. In order to sweep out the minute quantities of impurity vapors from the sample without volatilizing the uranium, a small amount of a volatile material, termed as 'carrier', is added to the sample. Pure gallium oxide, added to a concentration of 2 per cent in the uranium oxide, served as the carrier. When this mixture was heated by a direct current arc in a carbon electrode of special design, the carrier material and impurities were volatilized into the arc. The light of the arc was examined with a spectrograph which provided a spectrum of gallium plus the spectral lines characteristic of volatile impurities in the uranium. The uranium, remaining as a residue, was recovered readily from the electrode. This method permitted detection of 33 impurity elements, some in concentrations as low as a few tenths part per million. The carrier-distillation method served both the industrial producers and the Government in controlling the purity of uranium-base materials required in the atomic energy project.—(*Chemical & Engineering News*, March 17, 1947).

RADIO-ACTIVE ISOTOPES IN AGRICULTURAL RESEARCH

The last Auburn conference (December 18 to 20) presented a programme of technical papers outlying the fundamental considerations of radio-activity and reported on researches on the storage in soil and uptake of fertilizers and trace elements by plants; action of insecticides, fungicides, and weed killers on insects, plants, and animals ; effects of industrial air pollution and other wastes on plants and animals ; deficiency diseases and utilization of foods and essential minerals in crops and livestock. Reviewing the isotope distribution programme of the Atomic Energy Commission Dr Paul Aebersold said that radio-active forms of most of the elements that enter into biological processes can be made in large quantity with the uranium pile. With few exceptions the available radio-isotopes of these elements have half life periods sufficiently long (weeks, months and even years in some cases) ; such convenient half lives are very suitable for tracer experiments. Production by cyclotron is required for useful radio-isotopes of fluorine, manganese, and vanadium and for the longer-lived isotopes of sodium and arsenic. Nitrogen, oxygen and boron are the only biologically important elements for which there are no useful radio-isotopes. Aebersold disclosed that astetine, element 85, discovered and produced in the cyclotron, may be useful in medical research. The 7·5-hour At^{211} is an alpha emitter, has a short half-life, and behaves like iodine physiologically. If it were possible to produce it in quantity, it might be injected and go to the thyroid, irradiate the thyroid with alpha particles, and then disappear from the system in a short time. It may also be useful in radio-autograph studies of the thyroid. In addition to radio compounds, concentrated stable isotopes are available and can be used as tracers by mass difference determinations. According to Dr Aebersold hydrogen, carbon, nitrogen, oxygen, sulphur, potassium, calcium, iron, nickel, zinc, stronium, mercury and lead will play an important role. Concentrated isotopes of hydrogen, carbon, nitrogen and oxygen are sufficiently available by chemical exchange processes and of the other elements mentioned above are produced by electromagnetic separation. Hydrogen isotopes are of special interest in work on animal and plant physiology. Ample quantities of deuterium are now being produced and may be purchased at reasonably cheap prices. Tritium, another hydrogen isotope, is not yet available from A E C facilities. There are some tricky problems in its production and in its packaging.—(*Chemical & Engineering News*, January 5, 1948).

LATEST ANTIMALARIALS

Of the 80 compounds prepared at the University of Maryland, two are most successful as antimalarials. They are 7-chloro-4-(-4-diethylamino-1-methyl butyl amino)-quinoline or chloro-quine, and 8-(5-isopropyl-amino-amyl-amino)-6-methoxy-quinoline or pentaquine. Cloroquine had been patented by the Germans, but was unavailable in quantities sufficient for early clinical testing. Pentaquine was developed in analogy with plasmoquine.—(*Chemical & Engineering News*, 26, 454, 1948).

ELEVEN 'EXCEPTIONAL' GOVERNMENT SCIENTISTS

Apropos the editorial in this issue, the following news will be found interesting. None of the eleven scientists named below is a Fellow of the Royal Society and as far as our information goes they are all young and are not above 40. This move on the part of the government is a token of encouragement for young scientific talents of U.K.

Before the publication of the White Paper on the Scientific Civil Service (Cmd. 6679) in 1945, the higher salaries went with appointments carrying heavy administrative responsibilities, which meant that there was little encouragement for exceptional research workers who as a general rule had to decide whether they wanted advancement in the civil service sense even if this meant a diversion from original research because of administrative duties, or whether they would concentrate on research though this might involve considerable financial sacrifice. New special posts have been created so that research workers of exceptional talent can be promoted to the Senior Principal Scientific Officer grade, for which the salary scale is £1320—£1520, and yet remain free of administrative duties. Last year fourteen scientists were promoted under this scheme, and it was then stated that the Treasury would be prepared to authorize in all about forty such promotions.

Another eleven have just been announced. The scientists concerned are:

H. Barrell (National Physical Laboratory), W. Binks (National Physical Laboratory), H. Carmichael (Ministry of Supply), Dr C. M. Cawley, I. Fagelston (Admiralty), J. L. Hardy (Ministry of Supply), A. W. Mothersall (Ministry of Supply), B. Pontecorvo (Ministry of Supply), Dr R. H. Purcell (Admiralty), H. A. Sloman (National Physical Laboratory) and A. G. Tarrant (Road Research Station, D.S.I.R.)—(*Discovery*, April 1948).

PROCEEDINGS OF THE ZOOLOGICAL SOCIETY OF BENGAL

FOUNDED in 1946 the Zoological Society of Bengal is to be congratulated for their pioneer efforts in publishing a journal exclusively devoted to the progress of researches in varied aspects of Zoology in India. We are in receipt of the first issue of the Proceedings of the Society, published in March 1948, and containing papers that were read and discussed at the Society's meetings. There are papers dealing with chromosome cytology of insects by S. P. Ray Chaudhuri and his co-workers which shows the existence of an active school of a line of cytological investigations not hitherto pursued in India. Prof. H. K. Mookerjee and his co-workers have been continuing their studies on the embryology of Reptiles and Fishes. Of economic importance we refer to the works of D. Mukerji, M. Chakravorty and their collaborators, on the control of termites in India and on the parasitic protozoa causing diseases in fish respectively.

Printed in art paper the get up of the journal may be compared favourably with leading scientific journals in India and abroad for which the editor (Dr J. L. Bhaduri) and the printers deserve congratulations. The journal is to be published twice in a year with an annual subscription of Rs. 10/-. There are 22 text figures and 5 plates in the first issue. We have no doubt that this new journal will have a wide circulation and help the zoologists in India to have their works published in an Indian journal. Copies of the Proceedings may be had from the Honorary Secretary, Zoological Society of Bengal, 35, Ballygunj Circular Road, Calcutta.

ZOOLOGICAL SOCIETY OF BENGAL

THE Second Annual General Meeting of the Zoological Society of Bengal, was held on Sunday, the 25th April, 1948, at the University College of Science and Technology, 35, Ballygunge Circular Road, Calcutta. Prof. H. K. Mookerjee, President of the Society presided.

Addressing the meeting His Excellency Sri C. Rajagopalachari, who was the Chief Guest on the occasion, said: "You are really, if I may say so, engaged in the analysis of the mysteries of the living things of the world and since your battle is with living things inimical to man your science is of the greatest value. But if you narrow down your field of research to the particular utilitarian value, you will not achieve much. You must take a chance and carry on researches in fundamental science. It is a great and huge mystery and you must dig in all directions in order to find the wicked thing called truth, which may come luckily or may not come at all."

While discussing the attitude of the present governments towards scientific research in general His Excellency said: "You should know that the new authority that is governing India either in the provinces or at the centre are very keen to develop India, very keen to get India on in the map of science of the world, both applied and fundamental research. They are all very keen and very ambitious in this respect, but they do not know what is to be done exactly. You must be bold enough to tell them what you want and what you want them to do."

In his presidential address Prof. H. K. Mookerjee dwelt on 'Zoology in the service of man', in which he discussed at length on the importance of zoological researches in various aspects of Applied Zoology for the future benefit of India and stressed the need for the establishment of new institutes providing faci-

lities for investigation in animal genetics, sex physiology, etc. Lack of trained personnel in these subjects was another serious problem and with a view to remedying this defect, Prof. Mookerjee suggested that a specialized course of instructions be organized at the post-M.Sc. stage in all the universities in India.

Presenting the annual report, the honorary secretary (Dr S. P. Ray Chaudhuri) said that the total membership of the Society at the close of the year was 212. The Society undertook the publication of its proceeding involving a big financial commitment, but it was hoped that this journal would flourish, if the members would send their publications in the Society's proceedings instead of sending elsewhere.

Referring to the lack of research facilities in the Colleges affiliated to the University, Dr Ray Chaudhuri deplored the huge waste of scientific talent in the country. In addition, the salaries offered to the teaching profession was miserably inadequate. He hoped that these would be soon remedied.

The Society has been exploring avenues of co-operating with the authorities of the Zoological Gardens at Alipur, where again a wealth of scientific knowledge is running to waste.

The following were elected office bearers for the year 1948-49: *President*—Prof. H. K. Mookerjee, *Vice-Presidents*—Dr M. O. T. Iyengar and Dr S. P. Ray Chaudhuri, *Treasurer*—Sri A. N. Mitra, *Secretary*—Sri G. K. Chakraverty.

INDIAN DAIRY SCIENCE ASSOCIATION

THE inaugural meeting of the Indian Dairy Science Association (see SCIENCE AND CULTURE, February 1948, P. 336) was held on the 15th May, 1948 at the Indian Dairy Research Institute, Bangalore. Sir Datar Singh, Vice-Chairman, Indian Council of Agricultural Research presided.

In the course of his presidential address Sir Datar Singh pointed out that this Association fulfilled an urgent and long felt need for an organization which could co-ordinate and unify the activities of the dairy scientists of the country towards one common purpose, namely the rapid advancement of the nation's dairy industry. Dairying held a very important position in the Agricultural economy and prosperity of the country and for quite a long time, they had been acutely conscious of the necessity for not only increased production of milk but also improvement of its quality, its marketable life and its economic utilization in subsidiary food industries. If these problems were to be tackled successfully, intensive research work was called for on the best method of preservation of milk, production of clean milk, better handling and marketing of milk and milk products, etc. The dairy scientists of India had, therefore, a vital role to play in the reorganization of the industry.

The following were elected members of the Executive Committee: *President*—Sardar Bahadur Sir Datar Singh, *Vice-Presidents*—Dr Z. R. Kothavalla and Dr K. C. Sen, *Editor*—Dr K. C. Sen, *Treasurer*—Dr K. P. Basu, *Joint Secretaries*—Sri H. Laxminarayana and Dr N. N. Dastur.

ANNOUNCEMENTS

THE Seventh International Congress of Food and Agricultural Industries will be held in Paris from July 12-18, 1948 at the invitation of the French Government. The Congress will comprise thirty sections dealing with scientific, technical, economic, legislative and educational subjects. For details apply to 'Commission Internationale des Industries Agricoles' 18, Avenue de Villar, Paris.

Dr J. K. Chaudhuri and Sri A. K. Rai Chaudhuri of the Bose Research Institute, Calcutta, have been awarded the Premchand Roychand studentship of the Calcutta University for the year 1946 for their researches on the 'Mineral nutrition of jute plants' and 'Resonance theory of enzyme action' respectively.

Dr Chaudhuri is at present serving under the Government of India as the Plant Physiologist, at the Sugarcane Research Centre at Pusa (Bihar).

ERRATA

In April 1948 issue page 428 column 2 *read* H. N. De *for* H. C. De and in May 1948 issue page 461 column 2 line 19 *read* mango *for* many.

ACKNOWLEDGMENT

WE acknowledge with thanks the receipt of the following:

JOURNALS

1. *Science*—Vol. 106, Nos. 2758-2765, Vol. 107, Nos. 2766-2778. 2. *Scientific American*—Vol. 177, No. 6, Vol. 178, Nos. 1-4. 3. *Chemical Age*—Vol. 57, Nos. 1480-1485, Vol. 58, Nos. 1486-1501. 4. *Endeavour*—Vol. 7, Nos. 25 and 26. 5. *Discovery*—Vol. 8, No. 12, Vol. 9, Nos. 1, 3 and 4. 6. *Sky & Telescope*—Vol. 7, Nos. 2-7. 7. *Nature*—Vol. 159, Nos. 4046-4052, Vol. 160. Nos. 4053-4055, 4058-4062, 4064-4068, 4070-4078, Vol. 161, No. 4080. 8. *Science et Vie*—Vol. 62, No. 363, Vol. 63, No. 365. 9. *Technology Review*—Vol. 50, Nos. 1-5. 10. *Water & Water Engineering*—Vol. 50, Nos. 622, Vol. 51, Nos. 624-626. 11. *Geographical Review*—Vol. 38, Nos. 1 & 2. 12. *Journal of the Franklin Institute*—Vol. 244, Nos. 5 & 6, Vol. 245, No. 1. 13. *Journal of the*

American Chemical Society—Vol. 69, Nos. 11 and 12, Vol. 70, Nos. 1-3. 14. *Journal of Chemical Education*, Vol. 24, Nos. 11-12, Vol. 25, No. I. 15. *Science News Letter*—Vol. 53, Nos. 13 and 14. 16 *La Nature*—Nos. 3145, 3147, 3156. 17. *Atomes*—January 1948, April 1948. 18. *Journal of the Scientific & Industrial Research*—Vol. 6, Nos. 10-12, Vol. 7, Nos. 1 & 2. 19. *Current Science*—Vol. 17, No. 1-4. 20. *Jnan-O-Bijnan*—Vol. 1, No. 1-4. 21. *Proceedings of the Zoological Society of Bengal*—Vol. 1, No. 1, March, 1948.

Books

1. The Differential Geometry of Ruled Surfaces—Ram Behari. 2. Patrick Geddes in India—Jaqueline Tyrwhitt. 3. The Question of Henry James—F. W. Dupee. 4. Botany of the Living Plants—F. O. Bower. 5. Atomic Spectra—R. C. Johnson. 6. Geology of the Lizard and Menace—J. S. Flett. 7. An Introduction to Systematic Botany—S. Pattanayak. 8. The moment—Virginia Woolf. 9. The Royal Botanic Expedition by New Spain—H. W. Rickett. 10. An Introduction to Vertebrate Anatomy—Harold Madison Messer. 11. The Genetics of Garden Plants—M. B. Crane and W. J. C. Lawrence. 12. On Human Finery—Ouentin Bell. 13. Plant Physiology—Meirion Thomas. 14. English Naturalist from Neckan to Ray—Charles E. Raven. 15. Light and Matter—B. N. Sen. 16. Evolution and Ethics—T. H. Huxley and Julian Huxley. 17. The Alchemist in Literature and Arts—John Read. 18. The Vertical Man—W. G. Archer. 19. Prospects and Potentialities of Pakistan—Prof. Maneck B. Pithawalla. 20. The Back and its Disorders—Philip Lewin. 21. Modern Magnetism—L. F. Bates. 22. Men out of Asia—Harold Starling Gladwin. 23. A Catalogue of Insecticides and Fungicides—Donald E. H. Frear. 24. Annual Report of the Indian Waterways Experiment Station, Poona. 25. The Electrical Crafts—William H. Johnson & Louis V. Newkirk. 26. Indian Art—Sir Richard Weinstedt. 27. Telepathy & Medical Psychology—Jan Ehrenwald. 28. Science and the Nation—(Penguin Books). 29. Theoretical Aerodynamics—L. M. Milne-Thomson. 30. New Biology—M. L. Johnson & Michael Abercrombie. 31. Causes of Catastrophe—L. Don Litt. 32. The Kinetics of Reaction of Solution—E. A. Moelwyn Hughes. 33. Letters of Eric Gills—Walter Schewring. 34. Fundamental in Chemical Process Calculations—Otto L. Kowalke. 35. A Psychology of Growth—Bert J. Beverly. 36. Understanding of Yourself and Your Society—John M. Ewing. 37. Electron and Nuclear Counters—Serge A. Corff. 38. Technology of Plastics and Resins—J. Philip Meson & Joseph F. Manning. 39. Centenary of Marxism—Samuel Bernseins. 40. Mount Everest, 1938—H. W. Tilman.

BOOK REVIEWS

The Pardhans of the Upper Narbada Valley—By Shamrao Hivale with a Foreword by Verrier Elwin. Published in 1946 for "Man in India" by Oxford University Press. Pages XVI+230. Halftone Plates XII and black and white drawings 27.

The Pardhans are mainly found in the Central Province and Berar where they number 121,494 or slightly above 94 per cent of the entire tribe, according to the Census of 1941. They are also met with in Hyderabad, Bihar and Chattisgarh. They are a branch of the great Gond people who primarily occupy the C. P. and Berar. The author has not dealt with the entire tribe in the work under review but has studied a sample of it from the Dindori Tahsil of Mandla District. This sample numbers, in round figure, 4000 persons. The tract studied forms a part of the eastern end of the Satpura Mountains which is mainly occupied by tribal population with a few Hindu and Muslim colonies in the more important market centres.

The author has done well to take his readers into his confidence about the area, of investigation. Though he has not given the name of the villages where he worked it is evident from the Preface that he made Patangarh his headquarters. He is silent about the reason for selecting this area which is predominantly inhabited by the Gonds. Perhaps he was guided in this matter by his association with the Bhumijan Sevamandal which is situated here.

The book has been divided into eight chapters dealing with, among other topics, the distribution of the tribe, its social organisaton, occupations, religion, customs concerning birth, marriage and death, love and sexual life, position of women, and its domestic relations. The account abounds with many intimate

glimpses of Pardhan life and culture which could only be gathered by one who has identified himself with the people in every respect. But unfortunately this rich material has not been marshalled in a proper scientific manner. For example, we may refer to his account of the economic life. It is incomplete and unbalanced. A careful analysis of Chapters III and IV reveal that the main occupation of the Pardhan is ritual begging. Every Pardhan householder is connected with a number of Gond families from which he received at an interval of every three years certain dues. He visits 20 to 30 houses and receives a sum varying from Rs. 50 to Rs. 80/-. This occupies him for about three months. During this tour he is possibly accompanied by his wife and children and they all receive food from their clients. For the next two years and nine months the family has to depend, according to the author, on this sum of Rs. 50/- to Rs. 80/- which is simply absurd. From stray remarks strewn all over the book one can possibly reconstruct the other sources of his income which appear to be more important. Agriculture, cattle-rearing, kitchen-gardening and farm-service are some of these sources. From the garden at the back of his house the Pardhan produces according to the author, his staple food for at least two months before the rice or Kondon crop is harvested. If the average number of persons in a family be five then income from this source during the years of the last war and succeeding it, amounted at least to Rs. 50/- if not more. This annual income is not given its due consideration though the triennial income of Rs. 50/- to Rs. 80/- from ritual begging is held up as the main source of livelihood. Every house, according to the author, has a cattle-shed and presumably cattle too. But we are not informed for what purpose they are kept and what income is possible from this source. The author had the best opportunity to collect definite data on the economic life of the Pardhans of Patangarh and neighbouring villages where he lived and worked for 12 years. On the basis of these data he could have clearly established the comparative position of the different means of livelihood among this interesting people.

Almost in every chapter the author has utilised anecdotes to illustrate the customs and situations. They reveal the author's wide knowledge of the life of the Pardhan. But unfortunately these case-histories have not been properly handled. For example, he has dealt with the question of polygamy in detail and has tried to find out the causes behind it. Barrenness of the woman, desire for prestige and comfort on the part of the husband, love-affairs, levirate and sorrorate, recovery of debt, forceful intrusion of girls into the house of a chosen mate, etc. are stated as possible causes of polygamy. But certainly they do not occur in the same proportion in every case. The author has failed to realise the importance of this question. Even he has not thought it necessary to give the relative proportion of polygamy and monogamy in Pardhan society. The study of a limited field is justified on such detailed investigations and it is essential in modern ethnography. This technique could have been very profitably employed in other departments of Pardhan life, *e.g.* service-marriage, divorce, disposal of the dead body, etc.

The author has often attempted sociological, psychological, and philological interpretation of words and customs. This is a laudable attempt. But many of these interpretations would not stand the test of critical analysis. On page 66 he suggests that the word *ojha* (magician) has come from the exclamation 'ochha' or 'ojha' which a magician utters before he falls into a trance. The word is not only in use among the Pardhans but is found among other tribes and castes where this exclamation does not occur. The author might have found its true origin if he had consulted any work on Indo-European philology. On page 128 he offers two explanations for the sacrifice of a pig to Narayandeo, the Sun-god for recovery from disease. In the first explanation he states that the sacrifice had been originally made to a tribal deity who was later on supplanted by Narayandeo under Hindu influence. This appears to be quite reasonable but the author is not satisfied with it. So he offers a second explanation. In it he suggests that the sacrifice of an unclean animal like the pig to the purest of the Hindu gods was made in defiance of Hindu ideas of ceremonial cleanliness. He even thinks that Lafu Kaj (pig sacrifice) "may be a sort of parody of the sun-worship". Does man indulge in parody or defy other people's religious sentiments as a means of curing diseased persons? Scores of explanations of this type occur in the book.

The book bristles with a number of statements which it is difficult to believe without further evidence. The author tells us on page 156 "The men of Patangarh fell in love with the girls of Ghata" and they "would visit Gorakhpur bazaar in the neighbourhood of Patangarh and then spend the night in the open . . . eating and drinking and lying together without embarrassment". This surely went on for some time but the author does not say how long. At last one night (and not during the daytime) the girls of Patangarh (and not the wives) came to know of it and following their men, fought a "pitched battle in which the Ghata girls were driven away". Morgan, had he been alive, would have heartily thanked the author for supplying such reliable evidence of one of his favourite imaginary stages of social evolution.

Space does not permit us to show other serious defects of the book. In short, it may be characterised as the diary of a missionary rather than a work of

scientific ethnography. It proves that even the best facilities cannot produce a good work without good training.

T. C. D.

The Fig—By Ira J. Condit, Ph.D. Associate Professor of Sub-tropical Horticulture, University of California, Citrus Experiment Station, Riverside, 1947, Waltham, Mass. U.S.A., Published by the Chronica Botanica Co.

This is an interesting and useful publication devoted to the study of all the important aspects of Fig. The antiquity of the Fig and its association with human culture has been traced to remote times. Eversince the publication of Theophrastus who first gave an account of the Figs in his "Inquiry into Plants" numerous books, bulletins and papers have been written on this subject. The continued domestication of Fig and its commercial exploitation in advanced countries like Turkey, Italy, America and France where a first rate Fig industry is established has resulted in the investigation of the improvement of the Fig plant, the results of which are published in various journals and periodicals. In presenting the above volume to the public the aim of the author has been to gather within the compass of a single volume all the technical and historical information available on Fig. His intimate knowledge of the Fig industry of California and Texas qualifies him to speak with authority on the subject and it is gratifying indeed that the author has been able to place before the interested public such a comprehensive monograph on this remarkable group of plants. A perusal of the volume will amply convince anyone of the amount of labour put in and all the data furnished are of considerable value to those dealing with this important fruit.

The book is divided into 20 chapters extending to 220 pages. Chapter I deals with the antiquity of Fig and its association with religion, music, folklore and literature. The information is collected from various sources and makes delightful reading. In this section the author has failed to make any reference to the Banyan (*Ficus bengalensis*), *F. hispida*—an edible Fig in India and the Pipul (*Ficus religiosa*), which are sacred to the Hindus as abode of God and possessor of many secrets. The *Atharva Veda* contains many hymns and prayers to show that these trees were adored and held in deep veneration by the Hindus. Reference to *Bodhidruma* or tree of Enlightenment beneath which the Great Buddha realised spiritual inspiration and divine truth and its intimate connection with Buddhism has also been omitted. Nor he has mentioned anything about the Great Banyan tree of the Royal Botanic Gardens at Sibpur, the largest of its kind. Similarly no mention is made of *Ficus Krishnae*, a mutated variety of *F. bengalensis*, well known for its acidiform leaf which is often mystically associated with the name of Lord Krishna. Chapters II and III treat with the etymology, early history, origin and spread of the Fig in the East and West from its original home in the equatorial regions of Europe. This is followed by a Chapter on the systematics of of the genus Ficus providing a botanical key to the species and varieties under cultivation. In Chapter V, the author gives a morphological account of the different parts of the Fig plant, supplemented by figures illustrating anatomical details. The morphology of the Fig fruit and the process of pollination and caprification, which is an important aspect of Fig culture are described. Fig breeding for the production of improved varieties together with an account of the scientific achievements of Californian orchards are succinctly described in Chapter VI. Turning from the purely scientific to the commercial and marketing side, the author treats in Chapter IX and X with the well-known market varieties, their fruit characters, classification and grading for commercial purposes. It would have been better if coloured plates illustrating the characteristics of different varieties had been added in this section. The author has rightly stressed on the uniformity of the product which is an important factor in the development of any industry. One reason for the lack of success of the Indian Fruit industry has been the attempt to marketing the products of no uniform grade and the methods advocated for standardisation and certification of Fruit products can be adopted with advantage. Chapters XI, XII and XIII deal with statistical data about Fig production in different countries, the climatic and edaphic factors governing Fig introduction and its acclimatisation. Valuable suggestions with facts and figures, correct method of picking, harvesting and drying the fig crop to cater to the market demand are elaborately treated in Chapter XIV. The production of the dried Fig crop, the process of preservation and manufacture of secondary products is given in detailed manner in Chapters XV and XVI. The chemical composition, the therapeutic value of Fig and its products are dealt with in Chapter XVI. This is followed by a short account of the economics of Fig production and the organisation of Fig trade on co-operative lines in America and other countries The special effort of the Californian Fig Institute in fostering this industry is worthy of praise, and the establishment of a similar organisation in India would augur well for the future of Indian fruit industries. A Chapter is allotted for the fungal and bacterial diseases affecting the Fig plant, and the insect pests attacking fig and methods of control and eradication are treated in the last chapter.

A comprehensive bibliography and index are given at the end of the book which is highly useful. A glance at the chapters and remark in paragraph V of the author's preface shows the omission regarding practical hints concerning up to date horticultural information, which is regrettable in such a work.

On the whole this work is a praiseworthy publication and the author is to be congratulated for his laudable attempt in presenting the subject in such a clear, lucid and convincing manner. The references cited are carefully selected from fairly extensive literature, and bibliography is drawn up so as to make the information readily accessible to all. The paper and type are of good quality and the sequence of chapters proves much care in editing, for which the *Chronica Botanica* authorities deserve congratulation.

K. B. and M. A. S.

Botany of the Living Plant—By F. O. Bower, Published by Macmillan & Co. Ltd., London, Fourth Edition, 1947, Pp. xii + 699. Price 36s. net.

A text book of Botany for students primarily requires balanced treatment of its different branches. Professor Bower's book definitely fulfils this need, and has long been regarded as the standard British work of its kind. In this new edition the book has admirably maintained this tradition. The author has profitably taken the advantage of expert assistance of Dr Drummond and Dr Bond in the third edition, and that of Professor Wardlaw in this edition. The chapter on cryptogams have been specially revised with important alterations and additions by Professor Wardlaw.

The book contains a series of self-contained essays each "presenting the individual plant as a living, growing, self-nourishing, self-adapting creature" and its other biological relationships. But it appears that subject matter of some topics are scattered without advantage at least in two different essays. In modern texts on Plant Anatomy epidermal system includes stomata. But the author has deviated from this principle, and discussed stomata and epidermis separately. There are a few similar cases.

The groups of Algae and other lower forms have been rearranged, slightly altered and the nomenclature revised. The cyanophyceae has been separated from the schizophyta and placed between the chlorophyceae and phaeophyceae and bacteria between the Fungi and Bryophyta. Similarly the Filicales have been placed first in the Pteridophytic series.

The diploid condition among the green Algae, as in Siphonales, has been indicated with a view to show the diversity of life-cycle and parallel development of different orders. The same condition has been traced to other groups of Algae with reference to the alternation of generation. These commentaries together with the detailed discussion on the 'Alternation of Generations' are unique features of the book and the problems of evolution and alternation of generations have been made easily intelligible.

Portions of the chapter on "The relation of size and form in plants" have been rewritten and elaborated. It has been briefly explained in a few new paragraphs that the physiological problems facing the submerged green plants is one of "size and form". The discussion on the hypothesis as to the "relation of size and form" in the third edition has been condensed into a short concluding paragraph in this edition. The 'size and form' correlation has been advocated by the author, but the "mechanism by which this relationship is brought about" still awaits solution.

A few discrepancies still persist in this edition. In *Puccinia graminis* nuclear fusion in teleutospore takes place at maturity and not on germination and that the mycelium of *Phytophthora infestans* never spreads through the tissues down the haulms to the tubers.

The frontispiece has been replaced by a new photograph of the giant trees of California. It is surprising that some figures have been unnecessarily displayed at two places (p. 87 and 144, 456 and 461, 457 and 505, 455 and 502 etc.).

J. S.

LETTERS TO THE EDITOR

[*The Editors are not responsible for the views expressed in the letters.*]

OXIDATION OF FATTY OILS ON TEXTILE FIBRES

VEGETABLE oils which are used for the lubrication of textile fibres are olive and modified arachis oils. For the lubrication purpose oil is applied on fibres in a very fine film. Thus the surface/volume ratio is immensely increased. Increase in surface brings more oil molecules to come in contact with air and thereby facilitates oxidation.

The mechanism of oxidation is of utmost importance. A proper understanding of the mechanism may lead to the way of finding newer and cheaper oils and may thus help the industry.

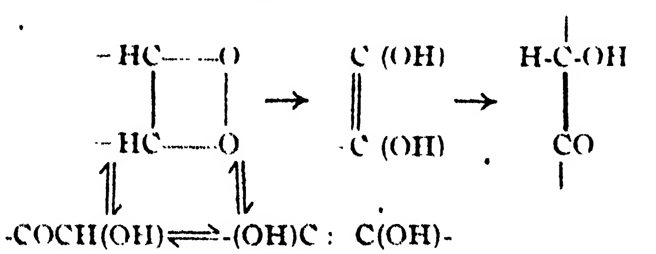
Reactions which occur when unsaturated glycerides are exposed to such conditions have been followed by many workers who have found out different intermediate and final products. Garner[1] is of opinion that the oxidation of oils proceeds by a chain mechanism. According to his view molecules of unsaturated acids are activated and react with oxygen to form activated peroxides. These in their turn activate other molecules.

(*i*) M + a Ma where, 'M' is a molecule of oil ;

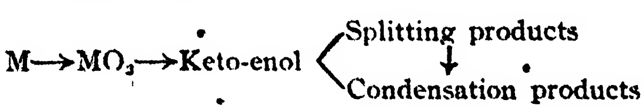
(*ii*) $Ma + O_2$ MaO_2, 'a' is externally supplied energy ;

(*iii*) $MaO_2 + M$ $MO_2 + Ma$ where, 'Ma' is an activated molecule.

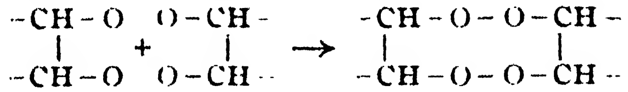
According to Ellis[2] the peroxides which are formed from unsaturated fatty acids or esters isomerize in the following way:



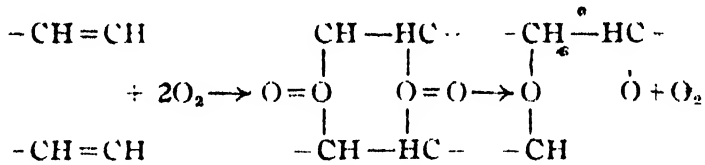
Further oxidation paths branch out from one or other of the tautomeric forms. Garner[3] summarizes the general course of oxidation into the mechanism which is given below.



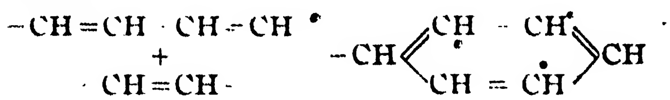
Condensation products include dimers, aldehyde, polymers and aldol condensation products. Most probable of these polymers and dimers are those formed by condensation of peroxides, *e.g.*,



From the constitution it looks that the ultimate products of this nature either dimers or polymers, which may have been formed, are not very stable compounds. It is generally agreed that polymerization proceeds through the medium of the double bonds existing within the fatty acid chains. The above hypothesis of dimerization through the formation of six membered ring involving the development of linkage through the medium of combined oxygen has not been supported by any experimental evidence. Morcusson[4] proposed a dimerization of almost this type:



The hypothesis of dimerization which has got some through experiments is that of Kappelmier[5] who postulates that dimerization takes place according to Diels-Alder[6] reactions between conjugated double bond systems and unsaturated compounds as follows:



Pre-requisite of this reaction to take place is that the fatty oil should contain conjugated double bond systems. In cases oils containing linoleic and linolenic acids isomerization should take place. This type of isomerization has actually been observed by Saha and Goswami[7] and other investigators. Then oils containing oleic acid should not polymerize according to this mechanism.

But if we accept Goswami's[8] view it will be very easy to show that even oils containing oleic acid would polymerize according to Kappelmier's[9] hypothesis. Goswami[10] suggested that during oxidation—

(*i*) there is formation of hydroxy acid ;

(*ii*) there is elimination of water molecule from the hydroxy acid so formed ; and finally

(*iii*) there is transference of double bond so as to produce conjugated stage.

According to this mechanism oleic acid changes in the following way—

$CH_3(CH_2)_7CH = CH(CH_2)_7.COOH$

$\downarrow$

$CH_3(CH_2)_5-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_2 \quad CH=CH \quad (CH_2)_7 \quad COOH$

$\downarrow$

$CH_3(CH_2)_5 \quad CH=CH-CH-CH(CH_2)_7-COOH$

The formation of intermediate compounds, which are found in oxidized oils, can be explained if this mechanism is accepted. There is evidence to the fact that peroxides which are said to be the primary products can more easily be formed from conjugated systems. Once peroxide is formed, next step of splitting of peroxides automatically follows.[8] Over and above polymerization according to Diels-Alder reaction is catalyzed by the presence of peroxides.

Thus oil oxidation probably takes place according to the following mechanism:

Unsaturated M $\longrightarrow$ Hydroxy M $\longrightarrow$ Conjugated M $\nearrow$ Peroxides $\longrightarrow$ Splitting products; $\searrow$ Polymerised products (Peroxides $\downarrow$ Catalysis Polymerised products).

A. SAHA

University College of Science & Technology,
92, Upper Circular Road,
Calcutta, 16-6-1947.

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ON THE NUMBER OF INTEGERS $\leqslant X$ AND FREE OF PRIME DIVISORS $> X^c$, AND A PROBLEM OF S. S. PILLAI

LET $f(x, c)$ denote the number of integers $\leqslant x$ and free of prime divisors $> x^c$. It is believed that the following results have been proved:[1]

(1) $f(x, c) = x\,\varphi(c) + O\left(\dfrac{x}{\log x}\right)$ for $x \geqslant 2$, and all c;

(2) $\varphi(c) > A\,4^{-\frac{1}{c}}\,c\left\{\Gamma\left(\frac{1}{c}\right)\right\}^{-2}$ for $c > o$,

where A is a positive constant, and $\varphi(c)$ is the function mentioned in my letter[1].

Related to the result (1) is the answer to a question raised by S. S. Pillai at the recent Indian Mathematical Conference at Waltair on 23-12-'47:

Is $f(x, c) = O(x, c)$ for $c \geqslant \dfrac{\log 2}{\log x}$ and $x \geqslant 2$?

The answer to this question is in the affirmative, and follows immediately from (1), if we observe that

$\varphi(c) = O(c)$ and $\dfrac{1}{\log x} = O(c)$ for $c \geqslant \dfrac{\log 2}{\log x}$.

Proofs of (1) and (2) will appear elsewhere.

V. RAMASWAMI

Andhra University,
Waltair,
2-1-1948.

[1] SCIENCE AND CULTURE, *13*, 465, 1948.

ON THE NUMBER OF INTEGERS $\leqslant X$ AND FREE OF PRIME DIVISORS $> X^c$.

THE following more precise results than those announced[1] have since been obtained, where $\varphi(c)$ is the function mentioned.[2]

Bounded functions $q_r(c)$ $r \geqslant o$ (where $q_o(c) = \varphi(c)$) exist such that, if r is any positive integer, then

$$(1)\ f(x, c) = x \sum_{n=o}^{r} q_n(c)(\log x)^{-n} + O\left(x^{c\left[\frac{1}{c}\right]}(\log x)^{-\left[\frac{1}{c}\right]}\right) + O\left(x(\log x)^{-r-1}\right) \text{ for } \left(\frac{1}{r+1}\right) \leqslant c \leqslant 1\,;$$

$$\text{and } (2)\ f(x, c) = x \sum_{n=o}^{r} q_n(c)(\log x)^{-n} + O\left(x(\log x)^{-r-\frac{1}{2}}\right) \text{ for } (\log x)^{-\frac{1}{2}} \leqslant c \leqslant \frac{1}{r+1}.$$

The restriction $c \geqslant (\log x)^{-\frac{1}{2}}$ in (2) can be replaced by $c \geqslant \log 2\,(\log x)^{-1}$ for $r = 1$ and 2, and the possibility thereof for greater values of r is under investigation.

Proofs or indications of proof of the above results will appear elsewhere.

V. RAMASWAMI

Andhra University,
Waltair,
21-1-1948.

[1, 2] SCIENCE AND CULTURE, *13*, 503, 1948; *13*, 465, 1948.

PRELIMINARY NOTE ON THE ACTION OF PENICILLIN IN EXPERIMENTAL PASTEURELLOSIS IN RABBITS

It has been reported[1,2] that *Pasteurella septica* is susceptible *in vitro* to penicillin and that the sulphonamides are capable of enhancing the inhibitory power of this antibiotic. The action of penicillin in experimental pasteurellosis caused by the above organism is reported here.

Seven rabbits weighing about 1300 g. were infected with 0·5 cc. of 10^{-7} dilution of eighteen hours' culture in plain broth of *Past.* 52, described earlier.[1] Two of the infected animals were kept as controls while the remaining five rabbits were injected subcutaneously after six hours of infection with 3000 units of penicillin at intervals of three hours for the first two days. The dose of penicillin was then reduced to 9000 units a day administered in two injections and the treatment was continued for two and a half days more. The animals showed thermal reaction after about 9 hours of infection. Both the control animals died of typical pasteurellosis within 24 hours while all the treated animals recovered. Penicillin, therefore, appears to be effective in pasteurellosis.

The combined effect of penicillin and the sulphonamides as well as the minimum effective dose of these antibiotics in pasteurellosis are under investigation.

N. B. Das
P. R. Nilakantan

Indian Veterinary Research Institute,
Mukteswar-Kumaun, 7-1-1948.

[1] Das, N. B. and Rawat, J. S., Science and Culture, *12*, 553, 1947
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STUDY OF THE HEAD-HAIR OF THE *PAROIS* IN THE DISTRICT OF JESSORE, BENGAL

In January, 1947, the writer spent several days at Hogladanga, a fisherman's village in the district of Jessore, Bengal, collecting ethnographical materials.

The *Parois* of Jessore are known as *Halder* in Nadia and *Manjhi* in Faridpur and Khulna. From somatic point of view they are a mesocephalic, mesorrhine medium statured, wavy haired and dark-brown complexioned people.

Hair samples were taken from the head (vertex) of 60 adult male *Parois*. The hair samples have been studied with respect to—

(1) Colour. (2) Form. (3) Size.

Colour.—The hair samples of the *Parois* were examined for colour by matching with the graded tones of the Fischer-Saller-Haarfarbentafel.

Distribution of colour tones of the *Paroi* hair :—

Fischer chart No.	No. of cases	Percentage
W	2	3·3
X	5	8·3
Y	53	88·3

Form.—It is the relative degree of flattening of the hair shaft which is expressed as an index. The technique for microscopic examination followed is that of Trotter*. The procedure consists of cleansing the hair in an ether-alcohol solution and measuring the greatest (d_1) and the least (d_2) transverse diameters of the hair shaft at a given level, fixing it on a glass slide by means of Canada balsam. Then the measurements are made under the microscope with help of an ocular micrometer and a hair rotator. "Index" is obtained from these diameters. Index $= \frac{d_2 \times 100}{d_1}$.

The mean index of 60 hair samples of *Parois* is 79·6.

Size.—Size or the area of a cross-section surface of the hair shaft is determined by multiplying half the greatest diameter and half the least diameter and the product by π, that is ($\frac{1}{2}d_2 \times \frac{1}{2}d_1 \times \pi =$ area of a cross-section).

The mean size or the area of cross-section surface of 60 hair shafts of the *Parois* is ·00214 Sq. m.m.

M. N. Basu

Department of Anthropology,
Calcutta University,
35, Ballygunj Circular Road,
Calcutta, 28-1-1948.

* Trotter, M. The Form, Size and Colour of Head-hair in American Whites. *Am. Jour. Phys. Anthropo. 15.*

OBSERVATIONS ON THE GROWTH OF *CEPHAELIS IPECACUANHA* (BORT.) A. RICH. IN CALCUTTA

Cultivation of *Cephaelis ipecacuanha* (Bort.) A. Rich. in India has so far been met with success only in certain hills in the Darjeeling District of Bengal. Since further availability of similar areas is limited it was considered advisable to attempt its cultivation in the plains of Bengal.

For this purpose some preliminary experiments were carried out on the growth of cuttings and of young plants. It was observed that high temperature of summer months *viz.*, April to June did not pre-

vent the natural growth of the cuttings and the young plants. Further their growths improved with the onset of rains and was found to be the best in August when the monthly average minimum temperature was 79·5°F and the mean humidity was 87.

In November, when the monthly average minimum temperature was 64·6°F and the mean humidity was 64, the cuttings and the young plants showed signs of decay as seen by the browning of their leaves (Fig. 1). The young plants and the

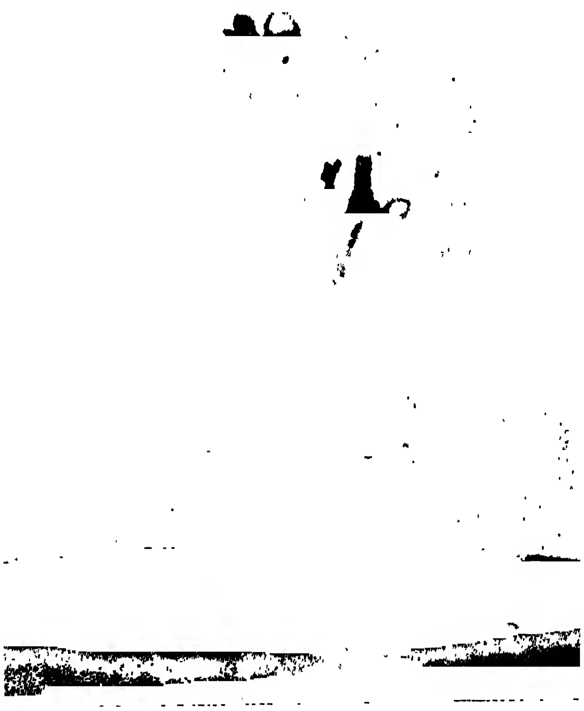

FIG. 1

cuttings were then subjected to artificially increased humidity and it was observed that their growth was revived to a great extent as seen by the development of the branches and leaves (Fig. 2). The observations indicate the favourable influence of lower temperature of winter months as compared with August provided the humidity is not allowed to decrease.

Anatomical structure of the leaves also indicate that the plants are sensitive to desiccation which was supported by the revival of growth of the cuttings and the young plants in November when they were grown under increased humid condition. The browning of leaves in November can be ascribed to the desiccatory effect of lowering of humidity in that month.

The work has been carried out under the direction of Sri S. N. Bal, Director, Pharmacognosy Laboratory, Government of India. We are grateful to Sri S. C. Sen, Director, Cinchona, Bengal for his

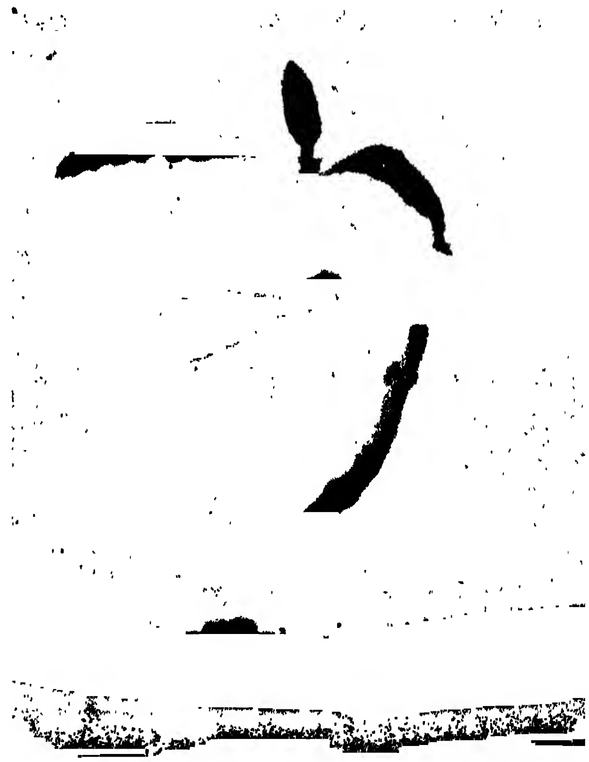

FIG. 2

help in providing us with plant materials. Details of the work will be published elsewhere.

GOPAL CHANDRA MITRA
DIPTISH CHAKRAVARTI

Bengal Immunity Research Institute,
39B, Lower Circular Road,
Calcutta, 23-2-1948.

PETROTECTONIC STUDY IN THE DARJEELING HIMALAYAS

A DETAILED study of the progressive metamorphism of the argillaceous and associated rock types in the Darjeeling Himalayas has recently been completed by the senior author.[1] It was thought advisable to commence petrotectonic studies to arrive at a kinematic basis of the metamorphism in the area. The specimens, though not properly oriented in the field, were handed over to the junior author for mineral fabric analysis. They have been used for fabric analysis with a hope to get some clue as to the mechanism of mineral grain orientation with-

out reference to the geographical co-ordinates. A few diagrams have thus been prepared. The probable geotectonic interpretation of three of the diagrams, two from the garnet and one from the kyanite zone are discussed here, as a preliminary to a detailed and regional fabric analysis

In all the cases non-selective non-collective 'c' quartz axes diagrams have been prepared in the *ac* fabric plane.[2,3,4] Schistosity or banding planes were chosen as *ab* planes. In specimen 138*, a highly schistose rock, the schistose bands are slightly wavy and a distinct lineation is visible on the *ab* plane produced by minute puckerings along these lines. This has been taken as the direction of the *b* fabric axis. Specimen 121, a quartz kyanite rock from the kyanite zone, does not show any rigid planar banding which though developed in the finer grained quartz assemblage has been at places cut athwart by stout kyanites. The banding too, when noticeable, is highly folded. A statistically preferred direction in the bladed kyanite crystals was chosen as the *b* axis. In such specimens, it should be mentioned, diagram from one section does not give a true idea as to the real nature of the mineral fabric in the whole rock mass. Indeed it has a typical non-affine fabric.

The diagram of the specimen from the garnet zone (138) shows a lack of statistically preferred orientation though the diagram may be said to have developed three girdles none of which is complete or perfect. The maximum concentration nowhere exceeds 5 per cent and the diagram has not developed any prominent maxima. There is a small *ac* girdle round *b* and a peripheral *ac* girdle the two joined by an imperfect *bc* girdle. The diagram is somewhat like figs. *k* and *m* of the schematic quartz orientation diagram of Fairbairn. We propose the following tentative interpretation of the diagram. The imperfect nature of the girdles are due to a failure to a complete reconstitution of the original fabric by recrystallization under the new stress system of the Hamalayan orogeny. The small *ac* girdles round *b* is probably a relict fabric caused by the original elongation of the crystals parallel to the rhombohedron (1011).

It may be mentioned that the diagram of quartz grain orientation of Siwalik sandstone by Ingerson and Raimisch a girdle 30 opp. round *b* is found—which after experimental determination of grain orientation, they ascribe to the original elongation parallel to (1011) in the quartz sand. The peripheral *ac* girdle is the ultimate result of forward movement parallel to *a* the girdling being caused by any process, rotation round *b* or rupture or translation gliding.

* Author's own number.

In the second specimen from the garnet zone (104) concentration is around girdles there being again no maxima developed. As in the former it shows an incomplete *ac* girdle at about 30° round *b* and a peripheral *ac* girdle joined by an imperfect girdle. The two diagrams from the garnet zone are essentially similar and the little difference may on examination from properly oriented specimens, come out to be unreal.

Specimen 121 from Kyanite Zone shows a maxima somewhat well developed (with a maximum concentration of 7·14 per cent), between *b* and *c* near the maxima III in Sander's synoptic diagram. The girdling however, is more prominent showing the common peripheral *ac* girdle. This girdle has a tendency to split up into a diagonal girdle intermediate in position between the *ab* and *bc* planes. Maxima III has been explained by Sander as translation on the Okl planes of the fabric by rupture or grain gliding, while Schmidt explains it as due to translation on T=(1011) with t=[2110]. The *ac* girdle as in the former case is explained (following Sander) as due to forward movement parallel to *a* with incidental rotation parallel to *b* causing the girdling round *b*. They may be due to grain rupture or grain gliding and intersection of a number of *s* planes in a direction parallel to *b*. A detailed investigation is being carried out and selective diagrams of cataclastic quartz in all the progressive zones from the chlorite to the garnet are to be studied before anything conclusive can be said of the mechanism of grain orientation.

It must be mentioned in conclusion that localized studies of fabric in an area involved in an excessively large scale regional movement that is associated with the Himalayan orogeny, cannot give a trusted picture of the movement pattern. It only serves as an instrument for further detailed and regional analysis.

S. Ray
S. Sen

Geology Department,
Presidency College,
Calcutta, 29-2-1948.

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3 Fairbairn, H. W., Structural Petrology of Deformed Rocks.
4 Knopf and Ingerson, Structural Petrology.

ON THE CONTROL OF *RHIZOCTONIA* ROOT-ROT OF *PAN* (*PIPER BETLE* L.)*

ROOT-ROT of *pan* (*Piper betle* L.) due to *Rhizoctonia solani* Kuhn is a serious menace in the *pan*-growing tracts of Sylhet[1]. For the last few years attempts have been made to suppress the parasite in the infected fields by growing different crops and thereby to control the disease.

An old *boroj* land where more than 50 per cent of the *pan* plants died due to the attack of *R. solani* was selected for the purpose. From the nature of the death of the plants it was evident that the land was almost uniformly infected with the fungus and that the infection was quite severe. But still an additional dose of infective material was introduced into the soil by incorporating cultures of the fungus into the stirred surface soil of the land. The entire piece of land was then divided into 30 equal plots, each 15 × 6 feet. Between the plots there were wide and deep drains separating each of the plots from the others.

The soil of the plots were then thoroughly spaded and prepared as usual and given the following treatments. Each treatment had six replications and the radomized block system of lay out was adopted. The treatments were as follows:

(*i*) *Ulu* grass (*Imperata arundinacea*) was planted in April, 1940 and allowed to grow in the plots during the years 1940, 1941, 1942 and 1943. In February, 1944 after cutting the top the plots were thoroughly dug up and the soil prepared for the planting of *pan*.

(*ii*) In March, 1940 *Aus* paddy (*Dumai*) was sown and harvested in June, 1940; thereafter *sail* paddy (*Lati sail*) was transplanted in July, 1940 and harvested in December, 1940. The same cropping programme was followed during the years 1941, 1942 and 1943. In January, 1944 the plots were ploughed and soil prepared for the planning of *pan*.

(*iii*) Potato was planted in October, 1940 and harvested in January, 1941. In March, 1941 jute was sown in these plots and harvested in August, 1941. In October, 1941 potato was again planted in these plots and harvested in January, 1942. In March, 1942 jute was again sown in these plots and harvested in August, 1942. It was then followed by potato and potato followed by jute as on previous occasions. Potato was the last crop harvested from these plots in January, 1944.

(*iv*) Tobacco was planted in October, 1940 and harvested in March, 1941. In May, 1941 *sunn* hemp was sown and ploughed under as a green manure crop during August, 1941. Thereafter tobacco was again planted, harvested and followed by *sunn* hemp as before. This cropping scheme was followed during the years 1942 and 1943. In 1944 after the harvest of tobacco in March, *sunn* hemp was not sown but the land allowed to remain fallow till the planting of *pan*.

(*v*) *Pan* was planted in July, 1940 and allowed to grow during the years 1940, 1941, 1942 and 1943. In April, 1944 the plots were cleared of the *pan* crop. The percentage of mortality of the *pan* plants under this treatment during the years 1941-44 was as follows:

Crop	Percentage of mortality				
	1940	1941	1942	1943	1944
Pan ..	7·8	18·5	19·6	23·4	4·2

In May, 1944 all these plots were carefully prepared for the planting of *pan*. All the plots were given the same treatments with respect to ploughing and basal manuring. Planting was done in July, 1944. Only healthy *pan* sets were planted and equal number of sets was planted in each of the plots. Planting was done at the same time and on the same day. Plants were thereafter given the same care and attention in respect to manuring, irrigation, earthing and other cultural operations.

The *pan* plants were kept under careful observation. The number of deaths was regularly noted and all the dead plants were microscopically examined to definitely ascertain that the death has been due to the invasion of the plants by *R. solani*. The average percentage of deaths observed during the years 1944-45, 1945-46 and 1946-47 is recorded in Table I.

TABLE I

AVERAGE PERCENTAGE OF DEATH OF *Pan* PLANTS DUE TO *R. Solani*

Treatments	Average percentage of death		
	1944-45	1945-46	1946-47
(*i*) *Ulu* grass	Nil	Nil	Nil
(*ii*) Paddy	4·2	6·7	5·0
(*iii*) Potato and jute	8·6	12·5	9·7
(*iv*) Tobacco and *sunn* hemp ...	3·2	4·0	4·2
(*v*) *Pan*	18·7	20·5	24·5

It will be evident from the data presented in Table I, that continuous cropping for four years with *ulu* grass completely controlled the parasite and gave a healthy crop of *pan* when planted afterwards. The

* This work was carried out at the Plant Pathological Laboratory, Sylhet.

other croppings, however, failed to completely control the disease but decreased it to save levels and gave a percentage of death far less than what was observed in the plots where *pan* was continuously grown for years. The results obtained further demonstrate that all crops were not equally effective in suppressing the parasite in the soil. *Ulu* grass was the most effective as it gave complete control, tobacco and *sunn* hemp ranked second, paddy occupied the third place whereas potato and jute ranked fourth and the last. But it is clear that *Rhizoctonia* root-rot of *pan* can be either completely or partially controlled by adopting cropping schemes as practised in this experiment.

S. CHOWDHURY

Central Potato Research Institute,
New Delhi,
16-3-1948.

[1] Chowdhury, S., *Proc. Ind. Acad. Sci.* Sec. B, *20*, 229-244, 1944

FLOWING BIREFRINGENCE OF SHELLAC SOLUTIONS

THE viscometric[1] and diffusion[2] measurements of particle shape have shown that the shellac molecules are anisotropic. In order to obtain more detailed information as to the form of shellac molecules in solution, the double refraction of the flowing solutions was studied under conditions of varying velocity gradient, concentration and nature of the solvents.

The actual experimental arrangements were as follows: Light from a powerful sodium lamp was passed through suitable filters to get mostly the light of wave length 5890 Å and then rendered parallel by a suitable combination of lenses. It was then polarized by a Nicol and passed through the solution of shellac placed in the annular space of a Couette apparatus, the inner cylinder of which could be rotated. The emergent ray was then condensed by a suitable lens system and received in a Nicol analyzer fitted with an eye-piece. The analyzer could be coupled with the polarizer and rotated together. When the inner cylinder was stationary the Nicol system was crossed such that the field of view was dark. The inner cylinder was then rotated with definite angular velocity, when the field of view became bright. The Nicol system was coupled and rotated together till the field was dark again. The angle between initial and final position gave the angle of extinction. The Nicol system was then separated, a quarter wave mica plate was placed in front of the analyzer and the analyzer rotated till the field was dark again. The position of the analyzer now gave the angle Δ from which birefringence $(n_e - n_o)$ was calculated as follows:

$$(n_e - n_o) = \frac{\Delta\lambda}{S\ 180}$$

where $\lambda = 5890 \times 10^{-8}$ c.m., S = thickness of the solution = 12 c.m. and Δ was the angle in degree.

The sign of birefringence with all the solutions of shellac was negative. Singer[3] has chosen for optically negative substances, the extinction angle as lying between 135° and 180°. The convention is adopted simply to define automatically the sign of double refraction by the values reported from the extinction measurements. With shellac solutions below 30 per cent concentration, the extinction angle was always 135°, independent of velocity gradient. This observation means, according to the theory of Boeder[4], that the Brownian movement of the shellac molecules, which are comparatively shorter than many synthetic polymers, is so intense that the rotary diffusion constant is very high. Thus the disorientation by Brownian movement is much quicker than the orientation by flow. This justifies the applicability of Kuhn's hydrodynamical equation in calculating the axial ratio of shellac molecules from viscometric measurements, where existence of complete Brownian movement has been assumed[1].

All solutions of shellac show a linear increase of double refraction with velocity gradient given in table I, confirming Boeder's orientation theory. There was no excessive increase of double refraction at higher velocity gradients in any case. This indicates that most probably the shellac molecules are not flexible or kinked. For if the molecules were flexible—curved or coiled up in solution—they would be straightened more and more with increasing velocity gradient; as a result, birefringence would increase much more rapidly than that predicted by the orientation theory, *i.e.*, a linear increase over a wide range of velocity gradient.

TABLE I

10 per cent Shellac in Ethyl alcohol

Velocity gradient (Sec.$^{-1}$)	Δ	$-(n_e - n_o) \times 10^8$	$-(n_e - n_o)/G \times 10^{11}$
601·2	8·0	21·79	36·26
500·3	6·6	18·00	36·00
431·4	5·6	14·97	34·71
360·0	4·6	12·64	35·10

My thanks are due to Dr P. K. Bose, Director, Indian Lac Research Institute, for his keen

interest and constant encouragement in this piece of investigation.

SADHAN BASU

Indian Lac Research Institute,
Namkum, Ranchi,
27-3-1948.

[1] Basu, *J. Ind. Chem. Soc.*, 24, 157, 1947.
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A DESTRUCTIVE "HELMINTHOSPORIOSE" OF BANANAS IN BENGAL

A DESTRUCTIVE epiphytotic of bananas[1] associated with a *Helminthosporium* sp. was noticed on the plantation of The India Collective Farms Ltd., (at Dattanagar, Nadia), during the last week of November, 1945. The symptoms of the disease, the morphology of the fungus, and the measures adopted to control the outbreak are mentioned below.

The infection generally begins at a point near the margin of the leaf. An inverted 'V' shaped area, pale brown in colour and surrounded by a bright yellowish zone of dying tissue is first noticed. The brownish area increases in size till it reaches the midrib, expanding in both length and width in irregular wavy zones. The infected region is often broadly lenticular with a pale ashy centre, bearing minute dark dots, which represent the conidia and the conidiophores of the fungus. From the midrib the infection spreads below into the pseudo-stem which begins to rot in consequence. Frequently some leaves could be seen in which all the laminae had completely shrivelled up, leaving only the bare rotting mid-rib. It was found, however, that in those plants in which the infection had not gone up to the mid-rib the central spindle of the unfolding younger leaves were free from infection. The leaves emerging from the infected spindles were, in contrast, reduced in size, stiff, torn up, or curved upon themselves.

There were nearly three thousand suckers in the plantation belonging to the two varieties, "Agneswar", and "Amritasagar" covering nearly three acres in all. They were planted in May, 1945 and the disease was first noticed during the last week of November, 1945. Most of the plants were bearing at the time the writer visited the farm in January, 1946. At this time the whole plantation had a sickly yellowish appearance. Not a single individual out of the three thousand present had escaped infection. Both the varieties appeared to be equally susceptible to the disease.

The fungus associated with the disease is *Helminthosporium* sp. The conidiophores of the fungus are dark to light brown to dark and arise singly or in groups of two to four with the two to three geniculations at the tip. Occasionally a branched conidiophore could be seen. The conidiophores measure $110 \times 8\ \mu$. ($43\text{-}138 \times 7\text{-}9\ \mu$) with three to five cross septa. The conidia are straight, broadly fusoid or elliptical with thick prominent walls of dark brown colour with green to olivaceous cell contents. The conidia are 1-6 septate, generally 3-5 septate, and measure $29\text{-}66 \times 12\text{-}17\ \mu$.

Wardlaw[2] has listed four species of the genus *Helminthosporium* on bananas. They are, *H. torulosum* (Syd.) Ashby, *H. gibberosporium* Curzi, *H. parasiticum* Sacc. and Berl., and *H. sacchari* Butler. Of these four fungi *H. torulosum* has been reported from the Central provinces on bananas.[3] The fungus on bananas from Bengal resembles *H. sacchari* closely in general shape of the conidia, their colour and size. But at this stage it is not possible to establish the identity of the fungus without carrying out further comparative morphological and pathogenicity trials.

The outbreak could be promptly controlled by the removal of the sources of infection, *viz.*, the infected plants or the infected parts of the plants followed by two prophylactic spraying with Bordeaux (5 : 5 : 50). The comparatively few individuals with infection upto the spindle were removed and destroyed. In the rest it was required to remove only the infected portions of the laminae. The structure of the banana leaf allows of this partial removal of the infected regions without any further damage being caused to the rest of the leaf. Thus a crop of 3000 suckers bearing or about to bear bunches valued at three rupees per bunch could be easily saved by taking recourse to simple control measures.

The writer wishes to express his gratitude to Lt. G. D. Mclaren, Deputy Director of Agriculture, Presidency Circle, Bengal, for providing facility during the course of the work and to the management of the India Collective Farms Ltd. for their cooperation in carrying out the control measures.

S. V. PADMANABHAN

Central Rice Research Institute,
Cuttack (Orissa).
7-4-1948.

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PREPARATION OF TRI-(*P*-CARBAMIDOPHENYL) ARSINE

Aromatic tertiary arsines are generally prepared by reacting aryl halides with arsenic trihalides in presence of sodium or by reacting magnesium aryl halides with arsenic trihalides. The following methods are also available, but not so extensively used: (1) Magnesium aryl halides are allowed to react with arsenious oxide in ether solution. (2) Some arylarsenoxides are decomposed when heated, yielding tertiary arsines and arsenious oxide. (3) Some tertiary arsines containing nitro- or amino-groups substituted in the benzene nucleus are obtained by reducing the corresponding arsenoxides with phosphorous acid or with tin and hydrochloric acid.

So far, no aromatic tertiary arsine appears to have been prepared directly from the corresponding arsonic acid derivative in one operation. It has now been found that, when a hot (water-bath temperature) aqueous solution of *p*-carbamido-phenylarsonic acid is treated with a minute quantity of hydriodic acid and then with sulphur dioxide, gradually a heavy oil separates which soon turns into a semi-solid mass on further treatment with sulphur dioxide. This semi-solid mass, after trituration with cold dilute alkali, is crystallized from dilute methyl alcohol in colourless crystalline powder, which shrinks at 175° and decomposes above 180°. It forms an additive product with mercuric chloride and has been found to be Tri (*p*-carbamidophenyl) arsine, $(NH_2-CO-NH-C_6H_4)_3$.As (Found: As, 14·9. $C_{21}H_{21}O_3N_6$ As requires As, 15·6 per cent).

T. N. GHOSE
SUKHAMOY BHATTACHARYA

Bengal Immunity Research Institute,
Calcutta, 12-4-1948.

A RAPID METHOD FOR ANALYSIS OF COLLOIDAL GRAPHITE

Analysis of Colloidal Graphite in oil is based on the separation of the suspension from the vehicle (oil) by dilution with some solvent and filtering through a bed of asbestos, fuller's earth, etc., and weighing the residue as such. Fruendlich[1], Holde[2], Vorberg[3] and Lyutin and Zakharova[4] have advocated the same method.

In course of investigations it was noticed that the residue separated from commercial colloidal graphite in oil contains in some cases, fairly large quantity of ash, mainly oxide of iron. In such cases, the above methods of analysis will give wrong results. So it was thought desirable to separate the suspension and estimate its graphite content. The following procedure was adopted:—

About 1 to 3 gms. of colloidal graphite in oil was taken in a weighed centrifuge tube of about 40 cc. capacity and the content was thoroughly mixed with about 30 cc. of a mixed solvent like benzene and absolute alcohol, benzene and ether, benzene and acetone and a few drops of glacial acetic acid and centrifuged for about 10 minutes at about 2,000—3,000 r.p.m., and the clear liquid was poured off. The procedure was repeated twice. The tube with its content was then dried at about 105°C for 10 to 15 minutes, cooled and weighed. The increase in weight is due to graphite and associated ash. The content of the tube was then transferred to a porcelain boat and ash was determined by combustion in an electric furnace. The decanted liquid can be evaporated to recover the vehicle for testing, if necessary.

The results of experiments carried out on a sample of colloidal graphite in oil of U. S. A. make, are shown in table I.

TABLE I

Expt. No.	Weight of material	Graphite & Ash %	Ash in Graphite
1.	1·8484	7·11	1·02
2	2·1010	7·07	1·01
3.	2·2504	7·05	1·09
4.	2·7500	7·08	1·06
5.	3·0110	7·10	1·07

The graphite content including ash of the same sample was 7·18% when determined in the usual method.

The rapid method described above is also suitable for analysis of paints, printing ink, etc.

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Department of Metallurgy,
Indian Institute of Science,
Bangalore, 12-4-1948.
K. MAJUMDAR

[1] Fruendlich, *Chem. Zeit*, *40*, 358-359, 1916.
[2] Holde, *Chem. Zeit.*, *41*, 32-33, 1917.
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